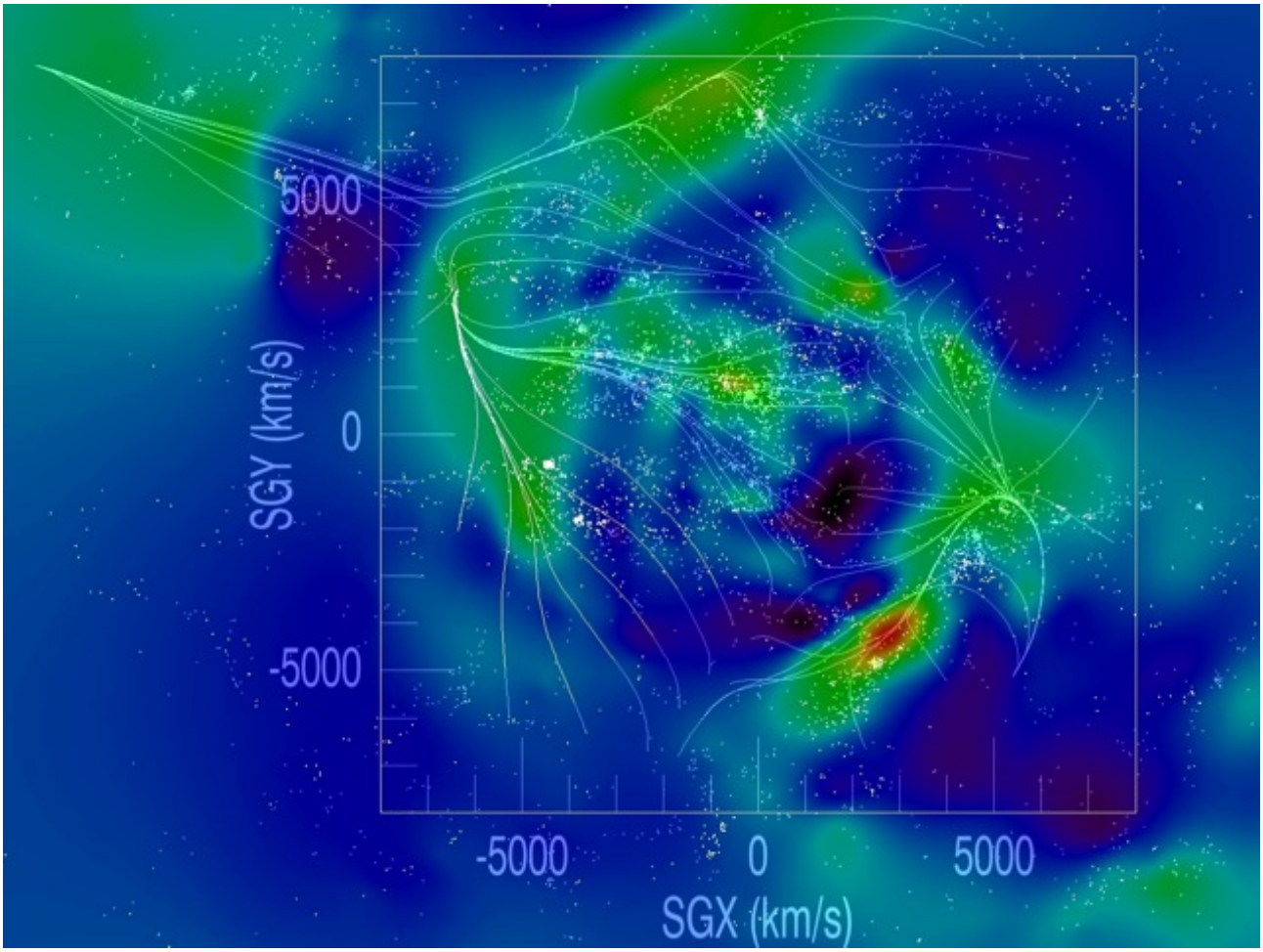
Cosmic Flows
Observations and Simulations

Marseille **June 3th-8th, 2013** France

This conference will be also honoring the career and 70th birthday of Brent Tully



Booklet of Abstracts

Scope

Rich new data sets on galaxy distances, from proper motion measurements of Local Group galaxies to sparse but accurate SNIa measurements at large distances, are leading to increasingly detailed maps of the distribution and motions of galaxies. The distribution of matter in the universe controls the motions of galaxies. Studies of galaxy flows on scales from infall onto groups to streams across 100 Mpc dimensions give information on the distribution of matter otherwise unavailable. Theoretical studies are making use of the observational constraints to infer initial conditions and then use this information to generate simulations that increasingly resemble the universe we live in.

Themes

- Measurement of distances, peculiar velocities, and proper motions
  - proper motions of nearby galaxies
  - HST Cepheid, TRGB, and SBF distances
  - TF and FP distances of large samples
  - SNIa distances
- Velocity field constructions and models
  - orbit reconstructions with non-linear models
  - linear theory models of velocity and density distributions
- Cosmological models
  - constrained simulations
  - development of clusters, filaments, and voids

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Abstracts

(in alphabetical order of speakers)

Miguel A. Aragon-Calvo: Hierarchical Dynamics in the Cosmic Web

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The hierarchical nature of the Cosmic Web can be seen in both the matter distribution and its dynamics. Making use of state-of-the-art analysis and visualization techniques I will show how the Cosmic Web can be dissected into a hierarchy of geometrical structures and dynamical domains, each reflecting different aspects of the Cosmic Web. I will also present preeliminary results on the effect of the hierarchical geometry/dynamics on halo formation and evolution.

Julien Bel: The clustering ratio test: Estimating the matter density parameter at high redshift

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The galaxy clustering ratio (Bel & Marinoni 2013, Bel, et al. 2013) is a new clustering statistic that provides access to characteristic parameters of the power spectrum of mass density fluctuations without the need to specify the galaxy biasing function, a model for peculiar velocity distortions nor the growing mode of density ripples. I will demonstrate the method using 3D redshift data from the SDSS (at z 0) and the VIPERS (at z 1) surveys. I will argue that this approach will be instrumental in searching for evidences of new physics beyond the standard model of cosmology and in planning future redshift surveys such as BigBOSS or EUCLID.

- Bel, J. & Marinoni, C. 2013, submitted
- Bel, J., et al. 2013, submitted

Maciej Bilicki: Cosmic flows with the largest all-sky surveys

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Two key probes of local cosmic flows – the bulk flow and the pull on the Local Group – require the 3D galaxy distribution on the whole celestial sphere to be known. Measuring the bulk flow traditionally requires peculiar velocities, but it is also possible with the use of all-sky redshift catalogues with uniform photometry (Nusser et al. 2011, Branchini et al. 2012). However, the largest surveys of that kind – 2MRS and PSCz – have median redshifts of only ~ 0.03. On the other hand, there exist much deeper all-sky galaxy catalogues, such as 2MASS and WISE. Neither of them have spectroscopic information and the way forward towards turning them into 3D surveys is through photometric redshift techniques. We are now compiling two largest photo-z catalogues covering the whole sky: one based on 2MASS, with a median $z \sim 0.1$, and another one using WISE data to probe at least twice deeper. Both will be applied to probe the bulk flow far beyond the reach of peculiar velocities.
Work in collaboration with Tom Jarrett (University of Cape Town) and John Peacock (Institute for Astronomy, Edinburgh).

- Adi Nusser, Enzo Branchini and Marc Davis, *Bulk Flows from Galaxy Luminosities: Application to 2MASS Redshift Survey and Forecast for Next-generation Data Sets*, ApJ, 735 (2012), 77, arXiv:1102.4189
- Enzo Branchini, Marc Davis and Adi Nusser, *The linear velocity field of 2MASS Redshift Survey, $K_s = 11.75$ galaxies: constraints on β and bulk flow from the luminosity function*, MNRAS (2013), 424, 472-481, arXiv:1202.5206

John Blakeslee : Surface Brightness Fluctuation Distances

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Surface brightness fluctuations (SBFs) are the variance in a galaxy image caused by random fluctuations in the integrated stellar luminosity per resolution element. The normalized SBF flux varies inversely with the distance

squared, and predictably with the stellar population. Measurements with HST/ACS have provided distances to early-type galaxies with unrivaled precision, allowing constraints on the 3-d structures of the Virgo and Fornax clusters, and a 2% measurement of their relative distance. The Coma cluster, the standard of comparison for fundamental plane and distant cluster studies, recently has been tied into the same precise SBF distance scale. The agreement between the theoretical model-based and empirical Cepheid-based SBF zero points supports the Cepheid distance scale. The SBF signal is much brighter in the near-IR, and we now have a calibration of the method for the WFC3/IR channel on HST, enabling accurate distances to at least 100 Mpc with only a couple orbits per galaxy. I'll summarize ongoing work and future plans for SBF studies.

Vincent Bouillot : Extreme pairwise velocities of galaxy clusters as a cosmological probe

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Motivated by observations showing the existence of high-redshift massive bullet cluster systems (e.g. Bullet Cluster (Mastropietro & Burkert 2008), we use a theoretical framework based on Extreme Value Statistics (EVS) to study the abundance and characteristics of high relative velocity halo pairs. We investigate various dependence of the pairwise velocity distribution of dark matter halo pairs in huge numerical simulations (21000 h^{-1}Mpc) featuring three realistic cosmological models. We find several bullet cluster systems in such a large numerical volume, thus probing with an unprecedented accuracy the high velocity tail of the v_{12} distribution. We show that this number depends little on redshift, in the range $z \sim 0 - 0.5$, but strongly on cosmology, since our quintessence dark energy model does not exhibit any bullet clusters whereas our phantom model have many of them. The accurate numerical measurements of the tail of the v_{12} distribution is further studied in the light of EVS. The inclusion of this complex modeling of the tail of the pairwise probability density function results in a higher probability of finding such a pair than in previous works (Lee & Komatsu 2010,Thompson & Nagamine 2012), thus lowering the tensions between the Bullet Cluster and the concordance ΛCDM model.

- Mastropietro C., Burkert A., 2008, MNRAS, 389, 967
- Thompson R., Nagamine K., 2012, MNRAS, 419, 3560
- Lee J., Komatsu E., 2010, ApJ, 718, 60

Enzo Branchini : From 2MASS to VIPERS: using redshift space distortions to trace the growth rate of fluctuations out to $z \sim 1$

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In this talk I present the new results obtained from the galaxy redshifts in the first public data release of the VIMOS Public Extragalactic Redshift Survey [VIPERS]. VIPERS is an ongoing survey that is observing spectroscopically an unprecedented sample of 100K galaxies brighter than $I_{AB} < 22.5$ in the redshift range $0.5 < z < 1.1$ and covering an area of 24 deg^2. Here I will consider the 55K objects in the first public data release, focusing on the estimate of the normalized growth rate of density fluctuations, $f\sigma_8$ from the redshift space distortions in galaxy clustering. The results of this analysis, which allow to obtain the highest redshift estimate of $f\sigma_8$ to date, are compared with those obtained at $z \sim 0$ from an alternative analysis of the "redshift distortions" of galaxy luminosities in the 2MRS $K_z = 11.75$ catalog.

Eva Busekool : HI properties of galaxies in the Ursa Major cluster and the Perseus-Pisces filament

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Blind HI imaging surveys have been carried out of the Ursa Major cluster and the Perseus-Pisces filament using the VLA. The goals of these surveys are to investigate the low-mass end of the HI Mass Function (HIMF), to study the Tully-Fisher relation, and to investigate HI morphologies and kinematics of the galaxies in these different environments.

Here we report on the HIMF of the Ursa Major cluster, which we measured down to HI masses of 2×10^7 $M_\odot$. The slope of the low-mass end of the HIMF ($\alpha \sim -1.0$) is quite different from the recent HIPASS (Zwaan et al. 2005) and ALFALFA (Martin et al. 2010) results, which are -1.37 and -1.33 respectively. The slope of the HIMF of the Ursa Major cluster is similar to the slope of its luminosity function (Trentham et al. 2001).

- Zwaan et al, *The HIPASS catalogue: Ω_{HI} and environmental effects on the HI mass function of galaxies*, 2005, MNRAS, 359, L30.
- Martin et al *The Arecibo Legacy Fast ALFA Survey. X. The H I Mass Function and Ω_H I from the 40% ALFALFA Survey*, 2010, ApJ, 723, 1359.
- Trentham et al. *The Ursa Major cluster of galaxies - III. Optical observations of dwarf galaxies and the luminosity function down to M_R=-11*, 2001, MNRAS, 325, 385

Jonathan Carrick : New constraints on cosmological parameters from the comparison of peculiar velocities with predictions from 2M++

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While the ΛCDM model is generally successful, there is some tension between the normalization of the power spectrum of density fluctuations on large scales (via bulk flows (Watkins et al. 2008)), those on smaller scales (via infall i.e. $f\sigma_8$ (Hudson et al. 2012)) and those recently obtained via Planck. In collaboration with Michael Hudson and Guilhem Lavaux, we present updated values of $\beta = \Omega_m^{0.55}/b$ and $f\sigma_8$ from the comparison of observed peculiar velocities and the predictions from a recently constructed deep galaxy redshift cat- alogue, 2M++, which draws from 6df, SDSS and 2MRS redshift surveys (Lavaux and Hudson 2011). We also discuss the convergence of The Local Group dipole for this new deep redshift sample.

- Richard Watkins, Hume A. Feldman and Michael J. Hudson, *Consistently Large Cosmic Flows on Scales of 100 Mpc/h: a Challenge for the Standard LCDM Cosmology*, Mon. Not. Roy. Astron. Soc. 392 (2008) 743-756 [arXiv:0809.4041].
- Michael J. Hudson and Stephen J. Turnbull, *The Growth Rate of Cosmic Structure from Peculiar Velocities at Low and High Redshifts*, ApJ 751:L30 (2012) [arXiv:1203.4814].
- Guilhem Lavaux and Michael J. Hudson, *The 2M++ galaxy redshift catalogue*, Mon. Not. Roy. Astron. Soc. 416 (2011) 2840-2856 [arXiv:1105.6107].

Nicolas Chotard : Type Ia supernova spectral analyses from the Nearby Supernova Factory

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Since the discovery that type Ia supernovae (SNe Ia) can be used as a good distance indicator and thus be employed as a powerful cosmological probe, several photometric and spectroscopic surveys have been observing these objects at low and high redshift. In this talk, I will review some of the recent results obtained by the Nearby Supernova Factory (SNfactory) collaboration, which has already collected more than 200 spectral time series of low redshift SNe Ia with optical spectrophotometry. After a short reminder of the SNfactory project and its current SNe Ia spectral sample, I will focus on different spectral analyses of SNe Ia standardization and diversity in the context of distance measurements.

Matthew Colless : Lessons for TAIPAN from the 6dF Galaxy Survey

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I will review the lessons learned from the Fundamental Plane peculiar velocity survey of early-type galaxies carried out as part of the 6dF Galaxy Survey. These lessons can be applied to improve the peculiar velocity sample obtained in the course of the planned TAIPAN galaxy survey. In the most ambitious version of TAIPAN, we will measure spectra and redshifts for ∼600,000 galaxies down to r∼17 over the whole southern hemisphere and as far north as δ=+20°. TAIPAN will measure H_0 to 1% precision from the low-redshift BAO scale. Combining TAIPAN, 6dFGS and SDSS,

we expect to derive Fundamental Plane peculiar velocities with close to 20% precision for >50,000 early-type galaxies over 75% of the sky.

Séphane Courteau : Musings on the Tully-Fisher Relation

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Reflecting upon Cosmic Flows 1999, I will review recent developments in the measurements of galaxy distances based on the Tully-Fisher and Fundamental Plane relations. I will also explore the theoretical underpinnings of these relations and see how this motivates our quest for tighter distance indicators.

Hélène Courtois : Cosmic Flows Project, analysis and simulations

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"Cosmic Flows" project is ongoing since 2006. It is bringing together unique expertise in radioastronomy, optical and space near-infrared surface photometry, theoretical astrophysics and numerical simulations. When analyzing the large scale structures and the bulk flow, we are learning our "cosmography". I will present the preliminary analysis derived from our new 2013 catalog (CosmicFlows-2). The Great Attractor region is deserving a closer look compared to our first generation catalog of data. Meanwhile Shapley and Perseus-Pisces superclusters are also entering the game at this scale.

Marc Davis : Why talk about HUGE Large Scale Flows?

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Taking into account the substantial inhomogeneities out to cz=10,000 km/s leaves only ∼200 km/s of large-scale flow that is unaccounted by the local galaxy distribution. This is a velocity that is consistent with LCDM, and furthermore there is considerable uncertainty in the transformation to the local group frame that could make the residual velocity even smaller. Many people fail to recognize that the gravity field derived from the 2MRS redshift catalog is completely consistent with the local velocity field, when in fact, it is a tremendous achievement of our understanding of the growth of structure in the universe.

Sylvain de la Torre : Probing the accelerating Universe with redshift-space distortions in Euclid

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Large-scale redshift-space distortions (RSD) in the galaxy clustering pattern result from the coherent motions of galaxies towards overdensities induced by structure growth in the Universe. From their modelling one can infer the linear growth rate of structure and test the cosmological model. In this talk I will present RSD and discuss their usefulness in the context of understanding the recent acceleration of the expansion of the Universe. I will review most recent RSD models and measurements. Finally, after a brief presentation of the Euclid mission, I will show the constraints that next-generation large spectroscopic surveys such as Euclid will provide on the growth rate of structure.

A.Doroshkevich, M.Demiański : DM halo formation at large and small redshifts

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We discuss the possible application of the well known semi analytical model of the DM halo formation for the approximate description of the evolution of earlier galaxies in a wide range of masses and redshift. The same model can be used to link the conventional redshift of the DM halo formation or completion with its mass what quantifies the dependence of halo formation process on the initial power spectrum. Results of our analysis of observed properties

of 41 DM dominated dSph galaxies and set of ~ 300 clusters of galaxies are well consistent with the ΛCDM like power spectrum of initial perturbations down to scale $\sim 10kpc$.

Ulrich Feindt : Investigating anisotropies in the local universe with the Nearby Supernova Factory

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Our Local Group of galaxies appears to be moving relative to the Cosmic Microwave Background with the source of the peculiar motion still unidentified. While this has been studied mostly using galaxies in the past, the weight of SNe Ia has increased recently with the continuously improving statistics of available low-redshift SNe. This talk will present results from an analysis of coherent peculiar velocities in the nearby Universe ($0.015 < z < 0.1$) using 117 SNe Ia measured by the Nearby Supernova Factory, as well the world literature SN data. We find evidence that the peculiar velocity field continues to point into the direction of the CMB dipole up to a redshift of 0.06 and hence can rule out the Shapley Supercluster as the primary source of the bulk. Furthermore we find the bulk flow velocity in the redshift shell at $0.06 < z < 0.1$ to be significantly smaller than the large amplitude "dark flow" reported by Kashlinsky et al. 2010.

- Kashlinsky, A., Atrio-Barandela, F., Ebeling, H., Edge, A., & Kocevski, D. 2010, ApJ, 712, L81

Martin Feix: Approaching peculiar velocities at $z \sim 0.1$

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Peculiar motion introduces systematic variations in the observed luminosity distribution of galaxies. As recently proposed in (Nusser et al. 2011), this allows one to measure cosmological bulk flows and to reconstruct the peculiar velocity field from large galaxy redshift surveys. Technically, this is achieved by maximizing the probability to estimate a galaxy's absolute magnitude given its observed apparent magnitude and redshift. Thus the approach is independent of galaxy bias and traditional distance indicators, which are prone to systematic errors. Using the NYU value-added galaxy catalog based on the SDSS DR7 data release (Blanton et al. 2005), we apply this method to measure the cosmological bulk flow out to a depth of ~ 400 Mpc$/h$. Our results are presented in the light of recent claims which suggest the presence of an anomalously large bulk flow on these scales. Including higher-order moments and using the corresponding posterior likelihood, we further estimate the (angular) velocity power spectrum in different redshift bins. Finally, we attempt to constrain cosmological parameters such as Ω_b and σ_8 directly from the SDSS data.

- Nusser2011 A. Nusser, E. Branchini, and M. Davis, *Bulk Flows from Galaxy Luminosities: Application to 2Mass Redshift Survey and Forecast for Next-generation Data Sets*, ApJ 735, 77 (2011), 8 pp. [arXiv:1102.4189].
- Blanton2005 M. R. Blanton *et al.*, *New York University Value-Added Galaxy Catalog: A Galaxy Catalog Based on New Public Surveys*, ApJ 129, 6 (2005), pp. 2562-2578 [arXiv:astro-ph/0410166].

Hume A. Feldman : Scale Dependent Cosmic Flows

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Modeling the cosmic velocity field, and especially estimating its lowest order moment, the bulk flow (BF) has been a popular pursuit among aficionados in the cosmological community for three decades now. Other than estimating the magnitude and direction of the flow, one of the main difficulties has been defining the scale of flow detected. Currently, it seems that the main contentious issue is exactly that, what is the scale of the flow? There is a nearly universal agreement as to the direction of the flow, however, there is a great disagreement as to the magnitude as a function of scale. The way various groups define the scale, and thus compare to theoretical expectations varies greatly, which lead to disagreements and therefore a lack of consensus among practitioners. However, it is essential to understand that the BF is not a parameter, it is a function. The BF function may or may not vary greatly with scale. In a series of recent papers (Agarwal & Feldman 2013, Agarwal et al. 2012, Feldman et al. 2010, Watkins et al. 2009) we developed and applied the Minimal Variance (MV) formalism to optimize and clearly define the scale of a particular analysis, using the width of the survey window function as a proxy for scale. Comparing the MV *ideal* window function to any analysis window function yields an unbiased estimate to the survey width (or scale) and thus provides a method to directly compare various independent results. Further, the formalism provides a way to discuss the flow of a volume, traced

by the survey objects (be it galaxies or clusters, SNe...), rather than the average flow of the the objects themselves. I will discuss the method, compare several recent analyses and show that the disagreements are not as significant as they appear.

- Agarwal & Feldman, MNRAS in Press (2013) ArXiv:1301.1039
- Agarwal, Feldman & Watkins, MNRAS 424, 2667-2675, (2012)
- Feldman, Watkins & Hudson, MNRAS, 407, 2328-2338 (2010)
- Watkins, Feldman & Hudson, MNRAS, 392, 743-756 (2009)
- Macaulay, Feldman, Ferreira, Jaffe, Agarwal, Hudson & Watkins, MNRAS 425, 1709-1717 (2012)
- Macaulay, Feldman, Ferreira, Hudson & Watkins, MNRAS, 414, 621-626 (2011)
- Abate & Feldman MNRAS, 419, 3482-3490, (2012)
- Turnbull, Hudson, Feldman, Hicken, Kirshner & Watkins MNRAS, 420, 447-454, (2012)

Stefan Gottlöber : Near field cosmology with constrained simulations

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During the last decade our understanding of the formation of structure in the universe grew substantially. Due to the non-linear nature of the gravitational dynamics and the complicated gas-astrophysical processes numerical simulations have been the driving force behind much of this theoretical progress. Cosmological simulations must cover a large dynamical and mass range. A representative volume of the universe should be large, but this comes at the expense of the resolution. To overcome this problem a new approach has been developed which consists of using observations of the nearby universe as constraints imposed on the initial conditions of the simulations. The resulting constrained simulations successfully reproduce the observed structure within a few tens of megaparsecs around the Milky Way. Zoomed high resolution gas dynamical simulations allow to study the formation of the Local Group in the right large scale environment. We have performed a series of such simulations within the CLUES project (Constrained Local UniversE simulations - http://www.clues-project.org).

François Hammer : About the possible origin of Local Group dwarfs

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Most of the M31 satellite galaxies are confined to a gigantic thin disc as recently discovered by Ibata et al. 2013. This recent discovery has puzzled the astronomical community, since it seems to contradict the present theory of galaxy formation. However, such a gigantic structure had in fact already been predicted by a model developed in 2010 (Hammer et al. 2010), which is based on the idea that M31 is the result of a major merger which occurred 5 to 6 billion years ago. During galactic mergers, enormous quantities of matter are ejected via gigantic tidal streams which form in a specific plane, called the orbital plane. When some of this matter Çfalls backÈ onto the galaxy, it does so along gigantic looped paths which are in fact predicted on the basis of gravity. The fact that virtually all the satellites are found along these calculated loops, as well as the prediction of all their motions, leaves little doubt about the pertinence of this mechanism. However, it does raise many questions about the origin of these galaxies. They were presumably formed in the tidal streams, which would imply that they should have no dark matter, in contrast to the huge amounts currently supposed.

- Ibata, R., Lewis, G., Conn, A. R. et al. 2013, Nature, 493, 62
- Hammer, F., Yang, Y. B., Wang, J. L. et al. 2010, ApJ, 725, 542

Wojciech A. Hellwing : Cosmic density-velocity relation: into the non-linear regime.

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Yan-Chuan Cai
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Using a suite of a high resolution N-body simulations together with the *Delaunay Tesselation Field Estimator* technique we obtain volume weighted cosmic density and peculiar velocity fields spanning 5 orders of magnitude in space and 6 order of magnitude in mass. We show that non-linear DM velocity divergence $\theta \equiv \nabla \cdot v$ power spectrum $P_{\theta\theta}(k)$ deviates significantly from the linear theory predictions already at $k \sim 0.3h$/Mpc. This discrepancy is even bigger, and starts at smaller wave numbers, when one concerns the velocity field reconstructed from the peculiar motions of Dark Matter haloes. Thus using usual linear theory estimator $P_{\theta\theta}(k) = f^2 P(k)$ introduce a significant systematic bias for scales $R <\sim 50h^{-1}$Mpc. We discuss implications of this findings for various cosmological probes relaying on velocity statistics. In additions we quantify the non-potential part of the velocity flow, namely the vorticity and shows that for the most of the scales of interest in cosmology its contribution to the velocity power spectrum is negligibly small. We also discuss possible improvements of existing models for non-linear velocity power spectrum and variance. Finally we briefly show how the non-linear density-velocity relation changes in non standard cosmologies.

Carlos Hernández-Monteagudo (on behalf of the *Planck* collaboration) : *Planck*'s constraints on peculiar velocities

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In this talk I will summarize the constraints imposed by ESA's mission *Planck* on the peculiar velocities of X-ray galaxy clusters in the MCXC catalogue, (Piffaretti et al. 2011)). I will show that *Planck*'s constraints on the kinetic Sunyaev-Zel'dovich (kSZ) effect in those clusters rule out giant void inhomogeneous models as alternative explanations for Dark Energy. Likewise, *Planck*'s kSZ constraints on peculiar radial velocity and bulk flows centered on the observer are found to be consistent with ΛCDM expectations.

- Piffaretti, R., Arnaud, M., Pratt, G. W., Pointecouteau, E., & Melin, J.-B. 2011, Astronomy & Astrophysics, 534, A109

Johan Hidding : The phase-space geometry of the Cosmic Web

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The Cosmic Web is the largest known structure in the Universe, its intricate pattern an imprint from the tiniest perturbations born in the first nano seconds of inflation, evolved by the physics of gravity and dark matter in the following billions of years. We will discuss the geometry and dynamics of this pattern in the framework of Eulerian and Lagrangian perspectives on the dark matter fluid (Shandarin et al. 2012). We revisit the mathematics of catastrophe theory (Arnold et al. 1982), showing how we can extract the skeleton of the Cosmic Web in the general case of potential flow, and more specifically the Zeldovich Approximation (Zeldovich1970). This novel way of representing the six dimensional phase-space structure of the system gives us new insight in the physical processes that govern structure formation and teaches us new methods of studying N-body experiments.

- Zel'dovich Ya.B., 1970, A&A 5, 84
- Arnold V.I., Shandarin S.F., Zel'dovich Ya.B, 1982, Geophysical and Astrophysical Fluid Dynamics, **20**, 111
- Shandarin S., Habib S., Heitmann K., 2012, Phys. Rev. D, 85, 083005

Yehuda Hoffman : From Cosmic Flows to Large Scale Structure

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There is more to peculiar velocities than bulk flows. Cosmic flows are unbiased tracers of the underlying large scale mass distribution and therefore can be used to uncover the large scale structure (LSS) of the universe. The algorithms of the Wiener Filter (WF) and constrained realizations (CR) of Gaussian random fields provide an optimal Bayesian framework for the reconstruction of the LSS from large scale surveys of peculiar velocities. The WF/CR methodology will be reviewed and its application to recent surveys of the peculiar velocities is to be presented.

Mike Hudson : Peculiar velocities on large and intermediate scales as tests of gravity and large-scale structure

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I will discuss some recent developments in peculiar velocities, including on the bulk flow on large scales from Type Ia supernovae (Turnbull et al. 2012) and peculiar velocities as tests of gravity (Hudson & Turnbull 2012). Time permitting, I will also discuss how they can be used as a probe of the intergalactic ionized plasma via the kinetic Sunyaev-Zeldovich effect (Lavaux et al. 2013), and our effort to map the galaxy density field on very large scales via the 2M++ compilation (Lavaux & Hudson 2011).

- Turnbull S. J., Hudson M. J., Feldman H. A., Hicken M., Kirshner R. P., Watkins R., 2012, MNRAS, 420, 447
- Hudson M. J., Turnbull S. J., 2012, ApJ, 751, L30
- Lavaux G., Afshordi N., Hudson M. J., 2013, MNRAS, 726
- Lavaux G., Hudson M. J., 2011, MNRAS, 416, 2840

Rodrigo Ibata : Satellite Alignments around the Andromeda galaxy

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I will present evidence that half of all dwarf galaxies surrounding our neighbour, the Andromeda galaxy, are aligned in an immense ($\sim$ 400 kpc diameter) but super-thin plane ($<$ 14 kpc) that appears to co-rotate as a single structure. This alignment is statistically highly significant (99.998%) and culminates many years of effort by our team of discovering the satellite galaxies and measuring accurate distances and radial velocities. This discovery conclusively demonstrates a high degree of correlation in the orbits/angular momentum of the satellite galaxies, the existence of which must be explained as a basic requirement of galaxy formation scenarios, but which is hard to reconcile with expectations from the prevailing Lambda Cold Dark Matter cosmological paradigm. Not only is it difficult to understand how such a thin feature with coherent kinematics can survive in the expected triaxial dark matter halo of the host, but such a feature is not a natural prediction of current formation scenarios where dwarf galaxies form, quasi-independently, within dark matter sub-haloes and subsequently merge with the host galaxy. Consequently, the impact of understanding the dark matter content of these darkest galaxies may be profound.

Salma Islam, Martin Hendry : A ROBUST method of exploring the parameters of peculiar velocity fields

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In this poster we describe a new, robust method for estimating the linear bias parameter β from galaxy peculiar velocity data. Our approach extends the ROBUST method developed by Rauzy and Hendry 2000 and Johnston et al. 2007: we estimate the bias parameter by requiring that corrected galaxy luminosities and peculiar velocities are uncorrelated. The key advantage of this approach is that we can use the entire galaxy survey to constrain β , even in the case where the galaxies have a broad luminosity function. Using mock surveys, we investigate our method's dependence on the spatial and luminosity distribution of galaxies.

- Stéphane Rauzy and Martin Hendry, A ROBUST method for fitting peculiar velocity field models, *MNRAS*, 316(3):621-630, August 2000 [http://adsabs.harvard.edu/cgi-bin/bib_ query?arXiv:astro-ph/0004207].
- Russell Johnston, Luìs Teodoro and Martin Hendry, Completeness - I. Revisited, reviewed and revived, *MNRAS*, 376(4):1757-1766, April 2007 [http://adsabs.harvard.edu/abs/2007astro.ph..3040J].

Russell Johnston : Reconstructing Gravity Beyond the Local Universe with Peculiar Velocities

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I will present a Bayesian method (Johnston et al. 2012) that aims to reconstruct spatial maps of the Newtonian gravitational potential Ψ derived from peculiar velocities of galaxies at redshifts beyond $z \sim 0.1$, where peculiar

velocities have been measured from distance indicators such as the Tully-Fisher relation. Since peculiar velocities are sensitive to the Ψ field, it is of interest to investigate whether it is possible to directly infer the Ψ field from velocity data from the next generation of galaxy redshift surveys at these moderate redshifts. This could then be compared to a reconstruction of the $(\Psi + \Phi)$ field from lensing, allowing detailed comparison of the Ψ and Φ fields as a test of general relativity.

- Johnston, R., Bacon, D., Teodoro, L. F. A., Nichol, R. C., Warren, M. S. and Cress, C., *Reconstructing gravity beyond the local universe with peculiar velocities*, ArXiv e-prints 1210.1203

Gyula I. G. Józsa : The Westerbork Northern Sky H I Survey

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In the near future, Apertif, a new receiver system of the Westerbork Synthesis Radio Telescope (WSRT), will increase the instantaneous field of view of the instrument by a factor of 25 to 8 square degrees. One of the ideas to exploit the new observing capabilities is to conduct WNSHS - the Westerbork Northern Sky H I Survey. WNSHS aims at mapping the neutral hydrogen line above a declination of 27° and out to a redshift of 0.26. Providing - spatially resolved - H I data of an unprecedented sample, WNSHS will enable relevant research on the H I content, evolution and large-scale structure of the nearby Universe. I will discuss the predicted capabilities of Apertif and WNSHS.

- *Apertif web page:* `http://www.astron.nl/general/apertif/apertif/`
- *WNSHS web page:* `http://www.astron.nl/~jozsa/wnshs/`

Nick Kaiser : Gravitational Redshifts and Cosmic Flows from Front-Back Asymmetry in Redshift-Space

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The distortion of the clustering pattern of galaxies in redshift surveys has been widely used as a probe of biasing and the growth rate of cosmological structure. Most studies have focused on the front-back symmetric distortion caused by peculiar motions (line of sight squashing from large-scale streaming *vs.* stretching from small scale incoherent motions). Recently Wojtak et al. 2011 have measured the gravitational redshift from the front-back asymmetry revealed by stacking $\sim 7,800$ SDSS clusters in redshift space. Here we describe how the interpretation of this measurement is complicated by 3 other kinematic effects that are generally of the same order of magnitude: a transverse Doppler (or time-dilation) effect (Zhao et al. 2012); a light-cone effect arising from finite light propagation time; and a surface brightness modulation effect arising from relativistic beaming (Kaiser 2013). We also show how, on larger scales, this effect becomes entangled with (and provides a probe of) large scale flows.

- WHH2011 R. Wojtak, S. Hansen & J. Hjorth, *Gravitational redshift of galaxies in clusters as predicted by general relativity*, Nature, 477, 567-569 [arXiv:1109.6571].
- ZPL2012 H. Zhao, J. Peacock & B. Li, *Gravity theories, transverse Doppler and gravitational redshifts in galaxy clusters*, [arXiv:1206.5032].
- NK2013 N. Kaiser, *Measuring gravitational redshifts in galaxy clusters* [arXiv:1303.3663].

A. Kashlinsky : Evidence of large scale bulk flow of X-ray luminous clusters from WMAP and Planck CMB data

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I will present and discuss evidence in the WMAP and Planck CMB data of large scale coherent motion of clusters of galaxies. The signal of the bulk flow comes from the statistically significant CMB dipole which remains exclusively at cluster positions. The dipole is measured at cluster apertures corresponding to zero CMB monopole and its amplitude correlates with cluster X-ray luminosities. The signal with such properties reflects the kinematic Sunyaev-Zeldovich component due to the clusters' bulk motion in the direction which happens to coincide - within the statistical uncertainties - with that of the all-sky CMB dipole. CMB filtering cannot imprint dipole with the above properties,

but, on the other hand, certain filtering schemes can erase it. I will discuss how this happens and the consistency (or not) of the large-scale motion with other measurements at much smaller scales. The results indicate that a part of the all-sky CMB dipole is primordial (non-kinematic) and may reflect the overall tilt of the Universe. This has important cosmological implications for the overall structure of space-time and may be a direct reflection of the Multiverse.

- Atrio-Barandela, F. *On the Statistical Significance of the Bulk Flow Measured by the PLANCK Satellite*, 2013, Astron. Astrophys., submitted. arXiv:1303.6614
- Atrio-Barandela, F., Kashlinsky, A., Ebeling, H. & Kocevski, D. *Cosmic Microwave Background filters and the Dark-Flow measurement*, 2013, ApJ, submitted. arXiv:1211.4345
- Atrio-Barandela, F., Kashlinsky, A., Ebeling, H., Kocevski, D. & Edge, A. *The Error Budget of the Dark Flow Measurement*, 2010, ApJ, 719, 77
- Kashlinsky, A.; Atrio-Barandela, F.; Ebeling, H. *Measuring the Dark Flow with Public X-ray Cluster Data*, 2011, ApJ, 732, 1
- Kashlinsky, A.; Atrio-Barandela, F.; Ebeling, H.; Edge, A.; Kocevski, D. 2010 *A New Measurement of the Bulk Flow of X-Ray Luminous Clusters of Galaxies*, 2010, ApJ, L81
- Kashlinsky, A.; Atrio-Barandela, F.; Kocevski, D.; Ebeling, H. *A Measurement of Large-Scale Peculiar Velocities of Clusters of Galaxies: Technical Details*, 2009, ApJ, 691, 1479
- Kashlinsky, A.; Atrio-Barandela, F.; Kocevski, D.; Ebeling, H. *A Measurement of Large-Scale Peculiar Velocities of Clusters of Galaxies: Results and Cosmological Implications*, 2008, ApJ, 686, L49

Igor D. Karachentsev : Low density structures in the Local Universe

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We present results of our search for low-density associations of galaxies, as well as empty volumes in the Local Supercluster and its vicinity ($D < 45$ Mpc). By percolation method we found 226 diffuse, non-virialized agglomerates with $n > 3$ members. Eight the most populated among them ($n > 25$) have following median parameters: linear size of ~ 6 Mpc, radial velocity dispersion of 170 km/s, virial mass-to-stellar mass ratio ~ 700 and a density contrast ~ 5. In the same volume, we also found 89 spherical cosmic voids having diameters from 12 to 24 Mpc. About 93% of them are overlapping, and form three hyper-voids. The largest one contains 56 initial spherical cells and extends in a horseshoe shape, enveloping the Local Volume and the Virgo cluster. A scarce population of the local voids are represented by dwarf late-type galaxies with a high gas content and moderate star formation rates. Most of them sit shallow near the surfaces of cosmic voids.

Jun Koda : Velocity power spectrum – simulation and observation

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I first present the effect of redshift-space distortion of velocity power spectrum. Redshift-space distortion is well known for density power spectrum, but a similar effect is often neglected for peculiar velocities. We found a large damping effect that alters the power spectrum by 50% at wave number $k \sim 0.1\,h\mathrm{Mpc}^{-1}$. I also talk about the measurement of velocity power spectrum from the 6dF Galaxy Survey peculiar velocity (Magoulas et al. 2012), using the method of maximum likelihood (for example Macaulay et al. 2012). We included the effect of non-linearity, redshift-space distortion, and also suppressed the uncertain nonlinear effect with a gridding method (Abate et al. 2008).

- Magoulas, C., Springob, C. M., Colless, M., et al., *The 6dF Galaxy Survey: the near-infrared Fundamental Plane of early-type galaxies* 2012, MNRAS, 427, 245
- Macaulay, E., Feldman, H. A., Ferreira, P. G., et al., *Power spectrum estimation from peculiar velocity catalogues*, 2012, MNRAS, 425, 1709
- Abate, A., Bridle, S., Teodoro, L. F. A., Warren, M. S., & Hendry, M., *Peculiar velocities into the next generation: cosmological parameters from large surveys without bias from non-linear structure* , 2008, MNRAS, 389, 1739

Renée C. Kraan-Korteweg : Determining peculiar flow fields 'in' the Zone of Avoidance

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Despite concerted efforts in most of the bands of the electromagnetic spectrum, the cartography of the extragalactic sky behind the Zone of Avoidance remains poor, and is particularly severe in redshift space. The full extent and mass distribution of dynamically important nearby large-scale structures like the Great Attractor, Perseus-Pisces and also the Local Void are available only from interpolations or reconstructions. Two nearly completed surveys will be presented that aim to fill this gap, and provide flow fields through the NIR Tully-Fisher relation. These are a NIR imaging survey of all HI-detected galaxies from the systematic deep Parkes Multibeam survey (HIZOA, Henning et al. 2005), as well as pointed HI-observations of extinction-corrected NIR bright galaxies in 2MASX visible with with the Nançay Radio Telescope. The latter are galaxies that are excluded from the so-called 'whole-sky' 2MRS (Huchra et al. 2012) and also the 2MTF survey (Masters 2008). Following a discussion and derivation of an optimal way of employing the Tully-Fisher to these partly obscured galaxies, as well as other systematic biases that may affect Tully-Fisher samples, results on newly discovered structures and preliminary results on flow fields will be presented.

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- Huchra, J.P. et al. ApJS 199, 26 (2012)
- Masters, K.L., ASP Conf. Ser. 395, 137 (2008)

Guilhem Lavaux : Self-consistent peculiar velocity field reconstruction from Bayesian analysis

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The reconstruction of an unbiased three dimensional peculiar velocity field is made hard due to the only availability of noisy distance indicators and redshift information. A number of methods have been proposed, such as the Unbiased Minimum Variance estimator (Zaroubi 2002) and the All Space Constrained Estimate (Nusser & Davis 2011). These methods are limited: they assume some cosmology and a correction on distances and then infer the peculiar velocities. These assumptions limit the constraints that can be derived on the growth of structure and the location of dark matter from peculiar velocity fields. I propose to extend the analysis using a Bayesian framework to incorporate cosmological parameters and distances as random variables. I will show this framework, its advantages and some early results obtained on halo catalogues.

- S. Zaroubi, *Unbiased reconstruction of the large-scale structure*, MNRAS (2002), 331, 4 [astro-ph/0010561]
- A. Nusser and M. Davis *The cosmological bulk flow: consistency with ΛCDM and $z \simeq 0$ constraints on σ_8 and γ*, ApJ (2011), 736, 2 [1101.1650]

Noam I Libeskind : Cosmic vorticity and halo spins

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In the standard model of cosmology, structure emerges out of a non-rotational flow and the angular momentum of collapsing halos is induced by tidal torques. The growth of angular momentum in the linear and quasi-linear phases is associated with a shear, curl-free, flow and it is well described within the linear framework of tidal torque theory (TTT). However, TTT ceases to be applicable as haloes approach turn-around when their ambient flow field becomes rotational. Subsequently, halos become embedded in a vortical flow field and the growth of their angular momentum is affected by the vorticity of their ambient velocity field. Using a cosmological simulation, we have examined the importance of the curl of the velocity field in determining halo spin, finding a significant alignment between the two: the vorticity tends to be perpendicular to the axis of the fastest collapse of the velocity shear tensor ($\mathbf{e}_1$). This is independent of halo masses and cosmic web environment. Our results agree with previous findings on the tendency of halo spin to be perpendicular to $\mathbf{e}_1$, and of the spin of (simulated) halos and (observed) galaxies to be aligned with the large-scale structure. It follows that angular momentum growth proceeds in two distinct phases. First, the angular momentum emerges out of a shear, curl-free, potential flow, as described by TTT. In the second phase, in which haloes approach virialization, the angular momentum emerges out of a vortical flow and halo spin becomes partially aligned with the vorticity of the ambient flow field.

- N I Libeskind, Y Hoffman, M Steinmetz, S Gottlöber, A Knebe, & S Hess *Cosmic vorticity and the origin halo spins*, 2013 ApJL 766, 15L

John Lucey : A Brief History of the Great Attractor

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The dominant feature of the local peculiar field is the Great Attractor (GA) flow. With the benefit of hindsight, a brief history of the GA flow is presented. Prior to the seminal work of the 7 Samurai there were signs that the (Hydra-)Centaurus direction was important. Conundrums from the initial discovery of this flow and the often ambiguous/overlapping definitions of the GA and the Hydra-Centaurus supercluster led directly to seemingly very conflicting results. Over 25 years later some confusion still exists and there are several aspects of this flow that are poorly known, e.g. the contribution that the mighty Shapley Supercluster makes to the GA flow. Key challenges for the new surveys will be highlighted.

John Lucey : A New Catalogue of FP Cluster Distances

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The fundamental plane (FP) for early-type galaxies relates the (central) velocity dispersion to the photometric parameters (effective radius and surface brightness) and can determine relative galaxy distances with a typical uncertainty of 25% (or better). FP studies of rich galaxy clusters are a key tool to map the local peculiar velocity field as the uncertainty on the derived distances are reduced by $\sqrt{n}$, where n is the number of FP cluster members. In addition, as other methods, e.g. Tully-Fisher, can be applied to the same rich clusters a valuable test of systematics can be made. Several large and high quality datasets now are available that provide independent measurements of FP parameters and the direct comparison of these datasets allow the potential systematic issues to be investigated. We present the results from inter-comparing velocity dispersion measurements from SMAC, NFPS, SDSS, 6dF, etc and photometric parameters derived from 2MASS, SDSS, Pan-STARRS, etc, with particular reference to the data for rich clusters. A new all-sky set of rich cluster FP distances has been constructed and basic aspects of the local peculiar velocity field determined.

Yin-Zhe Ma : Cosmic bulk flow: myth and truth

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The peculiar velocity field is one of the important probe of large scale structure. Its prediction from linear perturbation theory of ΛCDM should be rigorous tested against observational data. We constructed a hyper-parameter statistical method, to quantify the difference between the predicted velocity field from the density field probed by IRAS survey, and the direct measurement of galaxy velocities. We show that the hyper-parameter combination of ENEAR, Type-Ia supernovae and SFI++ catalogues can give a constraint on the amplitude of perturbation $f\sigma_8 = 0.38 \pm 0.05$, which is consistent with all other different measurements. We then apply this technique to study the cosmic bulk flow, we find that the previous found large bulk flow on scale of 50Mpc/h (Watkins et al. 2009) is mainly due to the mixture of catalogues with different calibrations and non-removal Malmquist bias. We find that the bulk flow on 50Mpc/h scales cannot provide strong evidence against LCDM model. We then construct a new likelihood function which considers the correlation between different distance shells. By applying this method to peculiar velocity catalogues, we can find the constrained cosmological parameters are consistent with WMAP 7-year measurement. Finally, I will discuss some of our recent work on the statistical method of considering correlation between different datasets (Ma et al. 2013).

- Y.Z. Ma, E. Branchini & D. Scott, 2012, MNRAS, 425, 2880-2891
- Y.Z. Ma, & D. Scott, 2013, MNRAS, 428, 2017
- Watkins R., Feldman H. A., Hudson M. J., 2009, MNRAS, 392, 743
- Y.Z.Ma, D. Scott, A. Johnson, & C. Blake, in preparation

Lucas Macri and the SH0ES team : The SH0ES project: H_0 to 3% and beyond

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The SH0ES project (P.I.: Adam Riess) aims to obtain increasingly more precise and accurate measurements of the Hubble constant using type Ia supernovae, calibrated via near-infrared observations of Cepheid variables. We minimized sources of systematic uncertainty by building a robust, differential distance ladder that uses the same telescope and camera (HST and WFC3) for all observations. The ladder is anchored on the maser galaxy NGC 4258 (with a large HST-based Cepheid sample from Macri et al. 2006), the Milky Way and the Large Magellanic Cloud. We have published determinations of H_0 with uncertainties of 4.8% (Riess et al. 2009) and 3.3% (Riess et al 2011). I will review our progress to date and present results from the current phase of the project, designed to yield a 1.9% determination of H_0. This will be achieved by doubling the SN calibrator sample and by obtaining high-quality parallaxes to an additional 11 Milky Way Cepheids.

- Macri, L.M., et al., ApJ 652, 1133 (2006)
- Riess, A.G., Macri, L.M., et al., ApJ 699, 539 (2009)
- Riess, A.G., Macri, L.M., et al., ApJ 730, 119 (2011)

Christina Magoulas : Modelling the 6dFGS velocity field and cosmological results

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The 6dF Galaxy Survey includes Fundamental Plane (FP) distances and peculiar velocities for nearly 9,000 early type galaxies, making it the largest and most homogeneous galaxy peculiar velocity sample to date. For each galaxy we derive a probability distribution of peculiar velocities using a Bayesian method as presented in the talk by Chris Springob. Using a maximum-likelihood approach, we measure the overall bulk galaxy motions from the 6dFGS velocity field from which we determine the range and influence of large-scale motions in the Local Volume. We find good agreement between these observations and the predicted velocity field constructed from the 2MASS Redshift survey. We also compare the galaxy density and peculiar velocity fields to establish the distribution of dark and luminous matter and better constrain key cosmological parameters such as the redshift-space distortion parameter. Additional cosmological results derived from the 6dFGSv velocity power spectrum, including the effect of redshift-space distortions, will be discussed by Jun Koda.

Dmitry Makarov, Lidia Makarova, Roman Uklein : The structure of the CVn I cloud of galaxies

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We studied the structure of scattered concentration of galaxies in the Canes Venatici constellation. We redefined the distances for 30 galaxies using the deep HST images using tip of the red giant branch method. A group of galaxies around M 94 is characterized by the median velocity $V_{LG} = 287$ km/s, distance $D = 4.28$ Mpc, internal velocity dispersion $\sigma = 51$ km/s and total luminosity $L_B = 1.61 \times 10^{10}\ L_\odot$. The projection mass of the system amounts to $M_p = 2.56 \times 10^{12}\ M_\odot$, which corresponds to the mass-luminosity ratio of $(M/L)_p = 159\ (M/L_B)_\odot$. This mass-luminosity ratio is significantly higher than the typical ratio $M/L_B \sim 30$ for the nearby groups of galaxies. The CVn I Cloud of galaxies contains 4Ũ5 times less luminous matter comparing with the well-known nearby groups, like the Local Group, M81 and Centaurus A. The central galaxy M 94 is at least 1 mag fainter than any other central galaxy of these groups. However, the concentration of galaxies in the Canes Venatici may have a comparable total mass.

Karen L. Masters and the 2MTF team : The 2MASS Tully-Fisher Survey (2MTF)

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The 2MASS Tully-Fisher Survey (2MTF) is in the process of constructing Tully-Fisher distances for a well defined sample of bright inclined spirals selection from the 2MASS Redshift Survey (2MRS; Huchra et al. 2012). 2MTF was initiated in 2006 as a way to enhance the cosmological information in the 2MRS, by providing a qualitatively better sample for velocity-density reconstructions. In particular the survey aims to minimise the size of the Zone of Avoidance. 2MTF has obtained new HI observations of ∼1500 galaxies using both the Parkes Radio Telescope (Hong et al. 2013) and the Green Bank Radio Telescope (Masters et al. in prep.). 2MTF will combine good quality width measurements from these data ($N \sim 600$) with archival widths (e.g from the Cornell Digital Archive, Springob et al. 2005) and measurements from the blind HI survey ALFALFA (Giovanelli et al. 2005). 2MTF will use these widths with a dedicated calibration of the NIR Tully-Fisher relation (Masters et al. 2008) to make a uniform and well understood sample of ~ 3000 galaxies with peculiar velocity measurements.

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- Hong, T., et al. 2013, MNRAS (in press; arXiv:1304.0882);
- Huchra, J. P., Macri, L. M., Masters, K. L., et al., 2012, ApJS, 199, 26
- Masters, K.L., Springob, C.M. & Huchra, J. P., 2008, AJ 135, 1738
- Springob, C.M., et al., 2005, ApJS, 160, 149.

Tom Mutabazi : The Norma Cluster: Distance and Peculiar Velocity via the Near-Infrared K_s-band Fundamental Plane.

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The Local Group's peculiar motion with respect to the Cosmic Microwave Background has been measured with high precision, e.g. 627 ± 22 km s^{-1} (Kogut et al., 1993) but the source of this motion is not clear. The fractional contribution of the local mass overdensity, particularly in the GA region (Lynden-Bell et al., 1988) and the distant Shapley Supercluster (Scaramella et al. 19989, Hudson et al. 2004) is not well known e.g.: Dressler & Faber 1990, Kocevski & Ebeling 2006. We attempt to disentangle these contributions by measuring a redshift-independent distance to the Norma cluster (at the heart of the Great Attractor (Kraan et al. 1996, Woudt 1998, Woudt et al. 2008), in order to determine its peculiar velocity. We have used high quality data of 31 early-type galaxies taken at the European Southern Observatory, using the SOFI instrument on the 3.6 m New Technology Telescope for the Norma cluster, and 2MASS images for 161 early-type galaxies within the Coma cluster. The relative distance (Norma with respect to the Coma cluster) is obtained using the NIR K_s-band Fundamental Plane (Djorgovski & Davis 1987, Dressler et al. 1987). We find a relative distance to the Norma cluster of $\sim 0.69 \pm 0.03$ (in units of Coma distance) and a peculiar velocity of 303 ± 268 km s^{-1} in the rest frame of the Cosmic Microwave Background radiation. In a pilot study, we have simulated the various sources of systematic errors, e.g. Galactic extinction and star-subtraction and found these to be negligible ($< 1.5\%$ effect on total extrapolated magnitude). We conclude that, the peculiar velocity of the Norma cluster, although consistent with zero, does not rule out a small gravitational influence onto the GA. This will be further explored, using a larger Norma cluster sample (~ 56 early-type galaxies in the JK_s-bands). A complementary redshift-independent distance measure will also be used for $\sim$ 28 spiral galaxies within the Norma cluster, using the Tully-Fisher method (Tully & Fisher 1977).

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- Dressler A., Faber S. M., 1990, ApJ, 354, 13
- Kocevski D. D., Ebeling H., 2006, ApJ, 645, 1043
- Kraan-Korteweg et al., R. C., Woudt P. A., Cayatte V., Fairall A. P., Balkowksi C., Henning P. A., 1996, Nature, 379, 519

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- Dressler et al., A., Lynden-Bell D., Burstein D., Davies R. L., Faber S. M., Terlevich R., Wegner G., 1987, ApJ, 313, 42
- Tully R. B., Fisher J. R., 1977, A&A, 54, 661

Sharvari Nadkarni-Ghosh : Non-linear density-velocity divergence relation from phase space dynamics

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The fractional overdensity and the peculiar velocity are the two main variables that characterize the large scale inhomogeneities of our Universe. In linear theory the density and the velocity divergence are proportional but this relation breaks down in the non-linear regime. We obtain a non-linear extension of this relation by examining the dynamics of the perturbations in a joint density-velocity divergence phase space. The method uses spherical collapse as a proxy to model the non-linear regime; however it does not rely on the knowledge of exact solutions and is therefore generalizable. With this method we extend existing non-linear formulae by Bernardeau 1992 and Bilicki & Chodorowski 2008 to include a dependence on the dark energy equation of state (w) and in addition obtain a new parametrization for the growth index γ. The explicit dependence on w is weak; the dominant dependence is through the matter density parameter Ω_m, in agreement with other investigations. Finally we demonstrate that using the density or velocity information alone to constrain cosmological parameters is subject to uncertainties in other quantities as σ_8 or n_s, but any degeneracies due to parameters of the primordial spectrum can be lifted when the same information is plotted on the joint density-velocity phase space.

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- F. Bernardeau, *The quasi-Gaussian density-velocity relationship*, ApJ **390**, L61(1992).
- M. Bilicki and M.J. Chodorowski, *The velocity-density relation in the spherical model*, MNRAS **319**,1796 (2008) [arXiv:0809.3513].

James Don Neill : The Wise Nearby Galaxy Atlas: Extending Tully-Fisher to the Full Sky with WISE

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The WISE Nearby Galaxy Atlas (WNGA) will provide surface photometry of ∼20,000 galaxies with sizes greater than one arcminute in the four WISE passbands. The photometry code we have developed for this project will provide the WISE W1 and W2 luminosities for the Cosmic Flows v2 Tully-Fisher measurements. We use a quality assurance step whereby a human assessment of contaminating objects allows them to be masked out. Shape parameters are also checked and elliptical apertures are used to measure the surface photometry and thus avoid the galaxy shredding typical of large image-survey pipelines. We present the resulting more-accurate galaxy total photometry applied to a calibration of the Tully-Fisher relation in W1 using a subset of ∼500 galaxies with well-known distances and compare these results with a calibration performed with IRAC imaging.

Mark Neyrinck : Tracking the Flow and Folding-Up of Cosmic Information

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At early times, the initial fluctuations were as though imprinted on the cold-dark-matter density sheet. As these fluctuations grow, some get stretched out in voids, and in other places they bunch together and fold to build structures,

in rough analogy to origami. In these structures, the small-scale fluctuations become obscured obscured from viewing in the coarse-grained density field. I will discuss some new insights into the dynamics of this process, and some limitations to the recovery of this information, both in principle, and (more interestingly because the problem might be solvable) in practice.

Adi Nusser: Beyond boundaries of redshift surveys: assessing the cosmological principle on "super-survey" scales

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The observed density field in redshift space is directly affected by the radial motions generated from mass fluctuations outside the volume occupied by the galaxy redshift survey. Those motions introduce redshift space anisotropies which are more pronounced at larger distances from the center of the survey, offering clues to the mass fluctuations on super-survey scales. Further, all estimates of the growth factor from redshift distortions are based on relations that assume that the velocity field is generated by mass fluctuations inside the survey. This may cause a few per cent uncertainty in these estimates.

Georges Paturel : 40 years of distance determination

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Before the Tully-Fisher relation (TF), there was no accurate distance criterion. Some correlations were found between absolute magnitude and measurable parameters (e.g., mean surface brightness, color index, morphological type code, shape of spiral arms etc...). A correlation between rotation velocity and absolute magnitude was suspected by M.S. Roberts and the team in which I started my carreer. But, people thought that an additionnal parameter should be added (e.g. morphological type code). In fact Tully and Fisher showed it is simply a one-parameter correlation (at least in a large domain of spiral galaxies). We will discuss the reason why the TF is so simple and so accurate. This new distance criterion makes it possible to resolve the famous dilemma about the Hubble constant H_0: Is it 50 or 100 (km/s)/Mpc (or something else) ? We will explain how the problem has been progressively clarified. Is there a consensus ? The situation is much better than 40 years ago, but some questions remain. We will discuss them.

Steven Phelps: The Numerical Action Method and the mass of MW and M31

Technion, Israel
Email: : steven.phelps@gmail.com The Numerical Action Method (NAM) has been used in a cosmological context since its introduction by Peebles (1989) as a precision tool to analyze the individual orbit histories of galaxies in the Local Group. We show that NAM can be used to place significant new constraints on the individual masses of the Milky Way and M31. The NAM method takes as input the observed positions, redshifts, distances, and intrinsic luminosities, as well as the standard model cosmological parameters, and assumes that linear theory correctly describes velocities at early times and that galaxies and their progenitors back in time can be approximated as simple paths representing the center-of-mass motions of their associated dark matter halos. By generating an ensemble of several thousand NAM solutions with varying values of MW and M31 masses, a minimum emerges which represents the best fit to the observational constraints. The results indicate a total Local Group mass consistent with that obtained from the Timing Argument (Kahn and Woltjer 1959), while breaking the degeneracy between MW and M31 masses. We test the method against simulated Local Group catalogs extracted from the Millennium Run to confirm that NAM predictions using this method are consistent with actual galaxy halo masses.

Daniel Pomarède : Cosmography of the Local Universe

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Cosmography, the creation of maps of the universe, reveals a complex web of clusters, filaments, and voids. These structures are associated with peculiar conformations in the cosmic flows: evacuation from voids, streaming along filaments, attractors. A cosmography of the nearby universe within a volume bounded at 8000 km/s on the Cardinal

Supergalactic Axes is presented using the Extragalactic Distance Database V8k redshift catalog. The three-dimensional reconstruction of cosmic flows and their inferred source density field are obtained with the Wiener Filter technique using the Cosmicflows-1 survey of galaxies peculiar velocities as input. The agreement between these reconstructed density and velocity fields and the cosmography derived from the redshift survey is explored using not only maps where prominent features are highlighted and named, but also video, where techniques for comparing different informations are employed and where the ability to translate and zoom helps the viewer follow structures in three dimensions and grasp the relationships between features on different scales while retaining a sense of orientation.

Anastasia Ponomareva : Detailed Anatomy of GALaxies: the Tully-Fisher relation as a tool to investigate internal structure of galaxies

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To investigate the internal structure of galaxies we consider in detail the 3.6 μm Tully-Fisher relation (Sorce et al. 2012) taking advantage of spatially resolved HI velocity fields. The main idea is to abandon the classical concept of the Tully-Fisher relation as the correlation using the width of global HI profile (Tully & Fisher 1977), and consider instead the detailed internal kinematics of gas in galaxies. An improved kinematic measure is implemented by deriving hidh-quality rotation curves from the velocity fields, taking into account warps and streaming motions in the disk due to spiral arms or a bar. This work is part of the Marie Curie Initial Training Network DAGAL, financed by the FP7 of the European Commission under REA grant agreement #289313.

- J.G. Sorce, H. M.Courtois, R.B. Tully: *The mid-infrared Tully-Fisher relation: Spitzer surface photometry , 2012, AJ, 144:133.*
- R.B. Tully and J.R. Fisher: *A New Method of Determining Distances to Galaxies, 1977, A&A 54,661-673.*

Mpati Ramatsoku : A blind wide-field Westerbork HI imaging survey

Kapteyn Astronomical Institute, University of Groningen, The Netherlands
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We present a blind HI-imaging survey with the Westerbork Synthesis Radio Telescope of the Perseus-Pisces filament where it crosses the Zone of Avoidance (Kraan-Korteweg & Lahav 2010). The survey comprises 35 mosaicked pointings covering ≈ 6 sq.deg and recession velocities of $cz \approx 2400 - 18000$ km/s. In preparation of the upcoming HI surveys with APERTIF (Verheijen 2008), we intend to reveal the cosmic large-scale structure behind the Milky Way and study the resolved HI properties of galaxies in different cosmic environments. Here some first preliminary results are presented.

- Kraan-Korteweg, R. C. & Lahav, O., *The Universe behind the Milky Way*, A&A Rev., 10, 211.
- Verheijen, M. A. W., Oosterloo, T. A., van Cappellen, W. A., Bakker, L., Ivashina, M. V., & van der Hulst, J. M. 2008, in American Institute of Physics Conference Series, Vol. 1035, The Evolution of Galaxies Through the Neutral Hydrogen Window, ed. R. Minchin & E. Momjian, 265-271

Mickael Rigault : Local Hα environment of Type Ia supernovae

Université de Lyon, 69622, France; Université de Lyon 1, France;
CNRS/IN2P3, Institut de Physique Nucléaire de Lyon, France
Email : rigault@ipnl.in2p3.fr Use of Type Ia supernovae (SNe Ia) as distance indicators has proven to be a powerful technique for measuring the dark energy equation of state. However, recent studies have highlighted potential biases correlated with the global properties of their host galaxies, sufficient in size to induce systematic errors in such cosmological measurements. In this talk I will present the results of a study of host galaxy regions in close proximity to SNe Ia in order to better analyze relations between SN Ia properties and those of their local environments. This work is a part of the *Nearby Supernova Factory* project, whose use of integral field spectroscopy enabled such a local host analysis. I will focus on Hα emission as an indicator of star formation. We find a significant offset in magnitude (after standardization) between SNe Ia from locally star-forming regions and those from passive regions. Since the fraction of SNe Ia from passive region is expected to decrease with redshift, this magnitude offset most likely introduces a bias in distance measurements using these standardizable candles. Furthermore, I will show that an environmental selection of Type Ia supernovae enables us to significantly reduce the dispersion of the Hubble diagram.

Mark Seibert : The Carnegie Hubble Program: Improving the accuracy of the Hubble constant with Spitzer.

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The Carnegie Hubble Program (CHP) is a program to measure a value of the Hubble constant with a final systematic uncertainty of only 3% by taking advantage of the Spitzer Space Telescope's unique mid-infrared capabilities. This involves using IRAC to undertake a fundamental recalibration of the Cepheid distance scale for the Milky Way, the Magellanic Clouds an local group galaxies and progressively moving out to the pure Hubble flow with the calibration and application of the mid-IR Tully-Fisher relation.

Edward Shaya : The Formation of the Local Group Satellite Planes

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It has recently been noted that the nearly 60 outer satellite galaxies in the Local Group are almost all in thin planes. In particular, we identify the galaxies with just 4 planes, 2 near M31, 1 near the MW, and 1 in the plane defined by the motion of the MW and M31 in the large scale frame. It has been conjectured that only a dissipative process, such as the gas settling after a merger or tidal encounter, could create such thin planes. However, if nearly all of the satellite galaxies in the Local Group were formed out of tidal debris, the Missing Satellite Problem would become a crisis. Instead, we are examining the conditions necessary for these planes to form out of the orbital dynamics naturally occurring in the Local Group. By combining Numerical Action Method with a backwards integration, we solve for all acceptable orbits that have early time peculiar velocities consistent ($<$25 km s^{-1}) of that expected by the early time gravity field. Then, we select those with present time velocities close to parallel to their respective planes, and we make use of the newly determined proper motions of M31, M33, IC10, and LeoI, to develop a best overall model. The self consistent solution is that nearly all galaxies were in a thin plane at z=4 that included the MW and M31 and was nearly perpendicular to their motions in the 50 Mpc frame of reference. This is essentially the wall of the Local Void. Some dwarf galaxies simply circulated within this plane, but some could have taken significant excursions out of the plane. However, the strong tidal field of the MW on M31 channeled the motions back into this plane. The N3109 group is found to have been an early participant, that interacted with the MW and was then lifted by the Virgo Cluster tidal field.

Anja Schröder : Galactic Extinction in the Zone of Avoidance

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To determine peculiar velocities of galaxies in the Zone of Avoidance it is important to apply the correct Galactic extinction correction. Since the Galactic extinction maps by Schlegel et al. 1998 are not calibrated for Galactic latitudes $|b| < 5\,\mathrm{deg}$, we have used the near-infrared colours of a complete magnitude-limited sample of 2MASS galaxies to determine a correction factor. The results are compared with other methods.

- Schlegel, D.J., Finkbeiner D.P., Davis M. 1998, ApJ 500, 52

Victoria Scowcroft : The Carnegie RR Lyrae Program

Carnegie Observatories, 813 Santa Barbara Street, Pasadena, CA, 91101, USA
Email : vs@obs.carnegiescience.edu

This talk will describe the Carnegie RR Lyrae Program (CRRP), a Warm Spitzer program designed to provide a Pop II calibration of the extragalactic distance ladder. The CRRP is complementary to the Carnegie Hubble Program (CHP) which uses Cepheids to study the Pop I distance scale. The CRRP includes parallax calibration the RR Lyrae mid–IR period–luminosity relation, and application of this to the RR Lyrae in galactic and LMC globular clusters. The Pop II distance scale is extended using the TRGB. I will present an overview of the program, our first results, and discuss how it complements existing distance scale programs.

Jenny Sorce : Constrained Simulations of the Local Universe using CosmicFlows-1 data

Institute of Nuclear Physics, Lyon, France

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Origins of Local galaxies' deviant motions from the Hubble expansion are not yet totally understood. To study the dynamics of Large Scale Structures, the international project Cosmic Flows maps the Local Universe. The first catalog of the project, called Cosmic-Flows-1, contains accurate galaxy peculiar velocities up to 40 Mpc. The reconstructed velocity field obtained with the Wiener-Filter technique is the first step to run simulations of the Local Universe. I will present the Constrained Realization method combined with the Reverse Zeldovich Approximation which provides the Initial Conditions for the second generation of CLUES constrained simulations of the Local Universe. I will also show the comparison observed/simulated Universe at z=0. These methodology refinements applied to our upcoming deeper catalog of distances should lead to better understand our motion at 630 $km\ s^{-1}$ with respect to the CMB.

Christopher M. Springob : 6dFGS Peculiar Velocities and Cosmography

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We describe the derivation of peculiar velocities for the 6dFGS survey. The survey includes $\sim$ 9000 galaxies for which we have Fundamental Plane data, and we derive peculiar velocity probability distributions for each of these galaxies using a Bayesian approach. We use adaptive kernel smoothing to create 3D maps of the velocity field, and offer a cosmographic description of the flow in and around the major features of large scale structure in the local universe, comparing our results to past observations, as well as the predictions from the 2MASS Redshift Survey reconstructed velocity field. We also discuss future Australian peculiar velocities such as the WALLABY survey being planned for the Australian SKA Pathfinder, which will provide Tully-Fisher distances and peculiar velocities for tens of thousands galaxies in the local universe.

Brent Tully : Cosmicflows-2

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Cosmicflows-2 is a compendium of 8000 distances contributed by 6 main methodologies: Cepheid PLR, TRGB, SBF, TF, FP, and SNIa. Our group has made major contributions with two of these methodologies. An effort has been made to assure that all the contributions are on a common scale, found to be consistent with H0=74.4 km/s/Mpc. A particular interest with Cosmicflows-2 is studies of deviations from Hubble expansion. Various aspects of issues related to galaxy flows will be discussed.

Marc A.W. Verheijen : Improving galaxy distances with HI rotation curves

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In the coming decade, blind HI imaging surveys of large areas of the sky with WSRT/Apertif and ASKAP will provide spatially resolved kinematics of extended HI disks in $\sim 10^4$ galaxies in the nearby Universe. This offers the opportunity to refine the kinematic measure of the Tully-Fisher (TF) relation, traditionally based on the width of the global HI profile, by considering the detailed shapes of extended HI rotation curves as derived from two-dimensional HI velocity fields. This approach may potentially decrease the observed scatter in the TF-relation, allowing for more accurate distance determinations to gas-rich galaxies in the local Universe. In this presentation I will discuss the current state of affairs and describe ongoing efforts to take advantage of the next generation of HI surveys.

Rien van de Weygaert : Assembly and Dynamics of Void Infrastructure: VGS31 and the search for void filaments

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We investigate the formation of a filamentary configuration of void galaxies, following the finding of the elongated galaxy group VGS31 in the Void Galaxy Survey. We use the high-resolution LCDM simulation CosmoGrid to explore how dark matter halo systems similar in mass, size and environment to VGS31 came to be. For these dark matter systems, we study the distribution of their neighbours, the large-scale structure in which they are embedded and their formation histories. We find that while VGS31-like systems have a large variation in formation time, the environment in which they are embedded evolved very similarly. The Nexus/MMF technique enables us to systematically follow the morphological and dynamical evolution of the wall-like and filamentary substructure in large-scale voids, allowing us to investigate the flow of outflow of matter and halos along walls and filaments. Each of the VGS31-like systems is embedded in a wall,that no later than $z = 0.5$ became the only prominent feature in its environment. Most haloes are also embedded in a thin filament of a few Mpc long inside the wall.

- Rieder S., van de Weygaert R., Cautun M., Beygu B., Portegies-Zwart S., 2013, MNRAS, subm.

Xin Wang : Kinematics of Cosmic Web and the Onset of Vorticity

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As an alternative way of describing the cosmological velocity field, we (Wang 2013) discuss the evolution of translational and rotational invariants constructed from the velocity gradient tensor. Compared with the traditional divergence-vorticity decomposition, these invariants, defined as coefficients of characteristic equation of the gradient tensor, enable a complete classification of all possible flow pattern in the dark matter comoving frame. Before the shell-crossing, different flow types are highly associated with cosmic web structure, which is usually defined via the matter density field. This is also true when the vorticity is generated after the shell-crossing. Such consistent evolution from the potential to vortical flow could be traced continuously by these invariants and therefore renders them as valuable statistical measurement. Furthermore, we also show that the vorticity direction of different vortical flow type align with cosmic web structure differently, which is consistent with the measurement of angular momentum direction of halos.

- Xin Wang, Miguel A. Arogon-Calvo, Alex Szalay, Mark Neyrinck, *Kinematics of Cosmic Web and the Onset of Vorticity*, (2013), in preparation

Saleem Zaroubi: The influence of redshift distortion on measuring the Epoch of Reionization

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The Epoch of Reionization (EoR), which marks the end of the Universe's "Dark Ages", is one of the least explored epochs in cosmic evolution. Studying this epoch the 21-cm hyperfine emission line of neutral hydrogen from the intergalactic medium is the main goal of the LOFAR-EoR key science project. In this talk I will show the main constraints we expect to obtain with LOFAR on the history of this epoch. I will also show the effects of redshift space distortions on the power spectrum of 21-cm radiation from the EoR using large scale N-body and radiative transfer simulations. LOFAR should be able to directly observe the power spectrum anisotropy due to redshift space distortions at spatial scales around $k \sim 0.1$ Mpc^{-1} after about 1000 hours of integration time.

Yi Zheng : Peculiar Velocity Decomposition, Redshift Space Distortion and Velocity Reconstruction in Redshift Surveys

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We propose a mathematically unique and physically motivated decomposition of peculiar velocity into three eigen-components: an irrotational component completely correlated with the underlying density field ($\mathbf{v}_\delta$), an irrotational component uncorrelated with the density field ($\mathbf{v}_S$) and a rotational (curl) component ($\mathbf{v}_B$). This decomposition has the potential to simplify and improve the RSD modeling. Specially, we identify a significant systematical error causing underestimation of the structure growth parameter f by as much as $O(10\%)$ even at relatively large scale $k = 0.1h$/Mpc described by a window function $W(k) = P_{\delta\theta}/P_{\delta\delta}$, which could be accurately fitted by $W(k) = 1/(1 + \alpha f^\beta \Delta^2_{\delta\delta})$ until relatively non-linear scales. We derive a new formula for the redshift space power spectrum. Using high resolution

simulations, we study the statistical properties of 3 velocity modes and verify some assumptions utilized in our RSD fomula. Under velocity decomposition, we also discuss 2 possible ways to fulfil the 3D $\mathbf{v}_\delta$ reconstruction. Both use the otherwise troublesome RSD in velocity reconstruction as a valuable source of information and can automatically and significantly alleviate the galaxy bias problem.

Ming Zhu: Large scale HI survey with the future FAST telescope

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The Five hundred meter Aperture Spherical radio Telescope (FAST) is a Chinese mega-science project that is currently under construction, with the aim to build the largest single dish radio telescope in the world. In this talk I will give a general introduction to the FAST technology and its science goals, and then report the latest status of the FAST project and discuss in more details on the HI large sky survey which is one of the key science project for FAST.

Abstracts Titles

Miguel Angel Aragon Calvo | Hierarchical Dynamics in the Cosmic Web
ulien Bel | Estimating the matter density parameter at high redshift
Maciej Bilicki | Cosmic flows with all-sky surveys: 2MASS, WISE and beyond
John Blakeslee | Surface Brightness Fluctuation Distances
Vincent Bouillot | Extreme pairwise velocities of galaxy clusters as a cosmological probe
Enzo Branchini | From 2MASS to VIPERS : using redshift space distortions to trace the growth rate of fluctuations out to z=1
Eva Busekool | The HI mass content of the Ursa Major cluster and the Perseus-Pisces filament.
Jonathan Carrick | New constraints on cosmological parameters from the comparison of peculiar velocities with predictions from 2M++
Nicolas Chotard | Recent results from the Nearby Supernova Factory
Matthew Colless | Lessons learned from 6dFGS for future peculiar velocity surveys
Stephane Courteau | Musings on the Tully-Fisher Relation
Hélène Courtois | Cosmic Flows Project, analysis and simulations
Marc Davis | Why talk about HUGE Large Scale Flows?
Sylvain de la Torre | Probing the accelerated Universe with redshift-space distortions in Euclid
Andrey Doroshkevich | DM halo formation at large and small redshifts
Ulrich Feindt | Investigating anisotropies in the local universe with the Supernova Factory
Martin Feix | Inferring cosmological peculiar velocities at $z \sim 0.1$
Hume Feldman | Scale-Dependent Flows : Measurements and Comparisons
Stefan Gottlöber | Constrained Local Universe Simulations (CLUES)
Francois Hammer | About the possible origin of Local Group - [Monday-Wednesday]
Wojciech Hellwing | Cosmic density-velocity relation: into the non-linear regime
Carlos Hernandez-Monteagudo | Planck constraints on peculiar velocities ! Thursday
Johan Hidding | The phase-space geometry of the Cosmic Web
Yehuda Hoffman | Reconstruction of the LSS from peculiar velocities
Mike Hudson | Peculiar velocities on large and intermediate scales as tests of gravity and large-scale structure
Rodrigo Ibata | A planar co-rotating group of satellites around the Andromeda Galaxy
Russell Johnston | Reconstructing Gravity Beyond the Local Universe with Peculiar Velocities
Gyula Jozsa | The Westerbork Northern Sky HI Survey
Nick Kaiser | Measuring Gravitational Redshifts in Galaxy Clusters
Benedict Kalus | Constraints on Anisotropic Cosmic Expansion from Supernovae
Igor Karachentsev | Low density structures in the Local Universe
Alexander Kashlinsky | Evidence of large scale bulk flow of X-ray luminous clusters from CMB WMAP and Planck
Francisco (Paco) Kitaura | Reconstructing the Primordial Fluctuations and the Cosmic Web of the Universe
Jun Koda | Velocity power spectrum, simulation and observation
Renee Kraan-Korteweg | Determining the flow field 'in' the Zone of Avoidance
Guillem Lavaux | Bayesian velocity field reconstruction from sparse and noisy distance tracers
Noam Libeskind | The velocity shear tensor and cosmic vorticity
John Lucey | A New Catalogue of FP Cluster Distances
Lucas Macri | The SH0ES program: measuring H_0 to 3% and beyond
Christina Magoulas | Modelling the 6dFGS velocity field and cosmological results
Dmitry Makarov | The structure of the CVn I cloud of galaxies
Karen Masters | The 2MASS Tully-Fisher Survey
Tom Mutabazi | The Norma Cluster: Distance and Peculiar Velocity via the Near-Infrared Ks-band Fund. Plane
Sharvari Nadkarni-Ghosh | Modeling non-linear large scale structure using Lagrangian Perturbation Theory re-expansions
Don Neill | The WISE Nearby Galaxy Atlas: Extending Tully-Fisher to the full sky with WISE
Mark Neyrinck | Tracking the Flow and Folding-Up of Cosmic Information
Adi Nusser | Beyond boundaries of redshift surveys: assessing the cosmological principle on super-survey scales
Georges Paturel | 40 years of distance measures : improvments and pending problems
Steven Phelps | The Numerical Action Method and the mass of MW and M31
Daniel Pomarède | Cosmography of the Local Universe
Anastasia Ponomareva | Detailed Anatomy of GALaxies: the Tully-Fisher relation, as a tool to investigate internal structure of galaxies
Mickael Rigault | Local environment of nearby Type Ia supernova. Evidence for dependencies.
Anja Schroeder | Foreground extinction corrections in the Zone of Avoidance
Vicky Scowcroft | The Carnegie RR Lyrae Program: A Parallel Path to the Hubble Constant
Mark Seibert | The Carnegie Hubble Program: Improving the accuracy of the Hubble constant with Spitzer
Ed Shaya | Solutions to Local Nonlinear Cosmic Flows

Jenny Sorce | Constrained Simulations of the Local Universe using CosmicFlows1-data
Christopher Springob | 6dFGS Peculiar Velocites and Cosmography
Brent Tully | Cosmicflows-2
Rien van de Weijgaert | Assembly of filamentary void galaxy configurations
Marc Verheijen | Improved galaxy distances using HI rotation curves (Thursday, Friday)
Xin Wang | Kinematics of Cosmic Web and the Onset of Vorticity
Saleem Zaroubi | The influence of redshift distortion on measuring the Epoch of Reionization
Ming Zhu | Large scale HI survey with the future FAST telescope

Program

• Sunday | June 2nd, 2013

ARRIVAL

• Monday | June 3rd, 2013

Chair Roland Triay

09:00 Registration

10:10 Coffee Break

10:30 Opening — Jean-Marc Pons

10:45 | Cosmicflows-2 — Brent Tully
11:25 | Determining the flow field "in" the Zone of Avoidance — Renée Kraan-Korteweg
11:50 | The 2MASS Tully-Fisher Survey — Karen Masters
12:15 | Foreground extinction corrections in the Zone of Avoidance — Anja Schroeder

12:30 Lunch Break

Chair Renée Kraan-Korteweg
14:25 | Cosmic flows with all-sky surveys: 2MASS, WISE and beyond — Maciej Bilicki
14:45 | The WISE Nearby Galaxy Atlas: Extending Tully-Fisher to the full sky with WISE — Don Neill
15:00 | The Westerbork Northern Sky HI Survey — Gyula Jozsa
15:15 | Large scale HI survey with the future FAST telescope — Ming Zhu
15:30 | Cosmic Flows Project, analysis and simulations — Hélène Courtois

15:55 Coffee Break

16:15 | 40 years of distance measures : improvments and pending problems — Georges Paturel
16:40 | A Brief History of the Great Attractor — John Lucey
17:05 | Musings on the Tully-Fisher Relation — Stephane Courteau
17:30 | A blind wide-field Westerbork HI imaging survey — Mpati Ramatsoku
17:40 | Detailed Anatomy of GALaxies: the Tully-Fisher relation as a tool to investigate internal structure of galaxies — Anastasia Ponomareva
17:50 | HI properties of galaxies in the Ursa Ma jor cluster and the Perseus-Pisces Þlament — Eva Busekool
18:00 | Free time for Discussions

19:00 Group photo near Palais du Pharo
20:00 Welcome party at Restaurant de l'Union Nautique Marseillaise (UNM)

• Tuesday | June 4th, 2013

Chair Hélène Courtois

09:00 | 6dFGS Peculiar Velocities and Cosmography — Christopher M. Springob
09:25 | Modelling the 6dFGS velocity Þeld and cosmological results — Christina Magoulas
09:50 | Velocity power spectrum - simulation and observation — Jun Koda
10:15 | Lessons for TAIPAN from the 6dF Galaxy Survey — Matthew Colless

10:40 Coffee Break

11:00 | A New Catalogue of FP Cluster Distances — John Lucey
11:15 | Surface Brightness Fluctuation Distances — John Blakeslee
11:40 | Low density structures in the Local Universe — Igor D. Karachentsev
12:05 | The structure of the CVn I cloud of galaxies — Dmitry Makarov

12:30 Lunch Break

Chair Matthew Colless

14:30 | The SH0ES project : H0 to 3% and beyond — Lucas Macri
14:55 | The Carnegie Hubble Program: Improving the accuracy of the Hubble constant with Spitzer — Mark Seibert
15:20 | The Carnegie RR Lyrae Program — Victoria Scowcroft

15:45 Coffee Break

16:05 | Satellite Alignments around the Andromeda galaxy — Rodrigo Ibata
16:30 | About the possible origin of Local Group dwarfs — François Hammer
16:55 | The Numerical Action Method and the mass of MW and M31 — Steven Phelps
17:10 | The Formation of the Local Group Satellite Planes — Edward Shaya
17:35 | The Norma Cluster: Distance and Peculiar Velocity via the Near-Infrared Ks-band Fundamental Plane — Tom Mutabazi
17:45 | Constrained Simulations of the Local Universe using CosmicFlows-1 data — Jenny Sorce
17:55 | Free time for Discussions

- Wednesday | June 5th, 2013

Chair Adi Nusser

09:00 | From Cosmic Flows to Large Scale Structure — Yehuda Hoffman
09:40 | Scale Dependent Cosmic Flows — Hume A. Feldman
10:05 | Self-consistent peculiar velocity Þeld reconstruction from Bayesian analysis — Guilhem Lavaux

10:30 Coffee Break

10:50 | Gravitational Redshifts and Cosmic Flows from Front-Back Asymmetry in Redshift-Space — Nick Kaiser
11:15 | Assembly and Dynamics of Void Infrastructure: VGS31 and the search for void Þlaments — Rien van de Weygaert
11:40 | The phase-space geometry of the Cosmic Web — Johan Hidding
12:05 | Reconstructing the Primordial Fluctuations and the Cosmic Web of the Universe — Francisco Kitaura

12:30 Lunch Break

Chair Hume A. Feldman
14:30 | Beyond boundaries of redshift surveys: assessing the cosmological principle on "super-survey" scales — Adi Nusser
15:10 | Cosmic density-velocity relation: into the non-linear regime — Wojciech A. Hellwing
15:35 | Non-linear density-velocity divergence relation from phase space dynamics — Sharvari Nadkarni-Ghosh

15:50 Coffee Break

16:10 | Peculiar velocities on large and intermediate scales as tests of gravity and large-scale structur — Mike Hudson
16:35 | Why talk about HUGE Large Scale Flows? – Marc Davis
17:00 | A ROBUST method of exploring the parameters of peculiar velocity Þelds — Salma Islam
17:10 | New constraints on cosmological parameters from the comparison of peculiar velocities with predictions from 2M++ — Jonathan Carrick
17:20 | Peculiar Velocity Decomposition, Redshift Space Distortion and Velocity Reconstruction in Redshift Surveys — Yi Zheng
17:30 | Free time for Discussions

20:00 Banquet at Restaurant Pavillon Flottant Société La Nautique

- Thursday | June 6th, 2013

Chair Yehuda Hoffman

09:00 | Cosmic vorticity and halo spins — Noam I. Libeskind
09:25 | Planck constraints on peculiar velocities — Carlos Hernandez-Monteagudo
09:50 | Inferring cosmological peculiar velocities at $z \sim 0.1$ — Martin Feix

10:05 | Kinematics of Cosmic Web and the Onset of Vorticity — Xin Wang
10:20 | Hierarchical Dynamics in the Cosmic Web — Miguel Angel Aragon Calvo

10:35 Coffee Break

10:55 | Reconstructing Gravity Beyond the Local Universe with Peculiar Velocities — Russell Johnston
11:10 | Extreme pairwise velocities of galaxy clusters as a cosmological probe — Vincent Bouillot
11:25 | Improving galaxy distances with HI rotation curve — Marc A.W. Verheijen
11:50 | Type Ia Nearby Supernova Factory — Nicolas Chotard
12:15 | Investigating anisotropies in the local universe with the Nearby Supernova Factory — Ulrich Feindt
12:25 | Local environment of nearby Type Ia supernova. Evidence for dependencies — Mickael Rigault

12:35 Lunch Break

14:00 Boat Trip to Calanques

• Friday | June 7th, 2013

Chair Mike Hudson

09:00 | Constrained Local Universe Simulations (CLUES) — Stefan Gottlöber
09:40 | Tracking the Flow and Folding-Up of Cosmic Information — Mark Neyrinck
09:55 | The clustering ratio test: Estimating the matter density parameter at high redshift — Julien Bel
10:10 | Cosmography of the Local Universe — Daniel Pomarède

10:25 Coffee Break

10:45 | The influence of redshift distortion on measuring the Epoch of Reionization — Saleem Zaroubi
11:10 | From 2MASS to VIPERS: using redshift space distortions to trace the growth rate of fluctuations out to $z \sim 1$ — Enzo Branchini
11:35 | Probing the accelerating Universe with redshift-space distortions in Euclid — Sylvain de la Torre
12:00 | DM halo formation at large and small redshifts — Andrey Doroshkevich
11:25 | Review & Concluding remarks — Nick Kaiser

12:55 Lunch Break

• Saturday | June 8th, 2013

DEPARTURE

Participants

Shankar Agarwal, LUTh Observatoire de Paris (FRA)
Miguel A. Aragon-Calvo, Johns Hopkins University Baltimore (USA)
Julien Bel, Osservatorio Astronomico di Brera (ITA)
Maciej Bilicki, University of Cape Town (ZAF)
John Blakeslee, Herzberg Institute of Astrophysics Victoria (CAN)
Vincent Bouillot, LUTh Observatoire de Paris (FRA)
Enzo Branchini, University Roma 3 (ITA)
Eva Busekool, Kapteyn Astronomical Institute (NLD)
Jonathan Carrick, University of Waterloo (CAN)
Nicolas Chotard, IPN Lyon (FRA)
Matthew Colless, Australian National University (AUS)
Georges Comte, Laboratoire d'Astrophysique de Marseille (FRA)
Stéphane Courteau, Queen's University at Kingston (CAN)
Hélène Courtois, Institut de Physique Nucléaire de Lyon (FRA)
Marc Davis, University of California at Berkeley (USA)
Sylvain de la Torre, University of Edinburgh (GBR)
Andrey Doroshkevich, ASC Lebedev Institute (RUS)
Pirin Erdogdu, Australian College of Kuwait (KWT)
Ulrich Feindt, University of Bonn (DEU)
Martin Feix, Technion Haifa (ISR)
Hume Feldman, University of Kansas (USA)
Stefan Gottlöber, Leibniz-Institute for Astrophsyics Potsdam (DEU)
François Hammer, GEPI Observatoire de Paris (FRA)
Wojciech Hellwing, ICM University of Warsaw (POL)
Carlos Hernandez-Monteagudo, CEFCA Teruel (ESP)
Johan Hidding, Kapteyn Astronomical Institute (NLD)
Yehuda Hoffman, Hebrew University Jerusalem (ISR)
Michael Hudson, University of Waterloo (CAN)
Rodrigo Ibata, Observatoire Astronomique de Strasbourg (FRA)
Salma Islam, University of Glasgow (GRB)
Russell Johnston, University of the Western Cape (ZAF)
Gyula Jozsa, ASTRON Dwingeloo (NLD)
Nick Kaiser, University of Hawai (USA)
Igor Karachentsev, Special Astrophysical Observatory (RUS)
Francisco Kitaura, Leibniz Institute for Astrophysics Potsdam (DEU)
Jun Koda, Swinburne University of Technology Hawthorn (AUS)
Renee C. Kraan-Korteweg, University of Cape Town (ZAF)
Guilhem Lavaux, Institut d'Astrophysique de Paris (FRA)
Olivier Le Fevre, Laboratoire d'Astrophysique de Marseille (FRA)
Gérard Lemaitre, Laboratoire d'Astrophysique de Marseille (FRA)
Noam Libeskind, AIP Potsdam (DEU)
John Lucey, Durham University (GBR)
Lucas Macri, Texas A&M University (USA)
Christina Magoulas, University of Melbourne (AUS)
Dmitry Makarov, Special Astrophysical Observatory (RUS)
Christian Marinoni, Centre de Physique Théorique (FRA)
Karen Masters, ICG University of Portsmouth (GBR)
Roya Mohayaee, Institut d'Astrophysique de Paris (FRA)
Tom Mutabazi, University of Cape Town (ZAF)
Sharvari Nadkarni-Ghosh, IIT Kanpur (IND)
Don Neill, California Institute of Technology (USA)
Mark Neyrinck, Johns Hopkins University (USA)
Adi Nusser, Technion Haifa (ISR)
Georges Paturel, University Claude Bernard (FRA)
Steven Phelps, Technion Haifa (ISR)
Daniel Pomarède, CEA Saclay (FRA)
Anastasia Ponomareva, Kapteyn Astronomical Institute (NLD)
Mpati Ramatsoku, Kapteyn Astronomical Institute (NLD)
Mickael Rigault, IPN Lyon (FRA)
Anja Schroeder, South African Astronomy Observatory (ZAF)

Victoria Scowcroft, Carnegie Observatories (USA)
Mark Seibert, Carnegie Institution for Science (USA)
Ed Shaya, University of Maryland (USA)
Jenny Sorce, Institut de Physique Nucléaire de Lyon (FRA)
Christopher Springob, The University of Western Australia (AUS)
Roland Triay, Centre de Physique Théorique (FRA)
Brent Tully, University of Hawaii (USA)
Rien van de Weijgaert, Kapteyn Astronomical Institute (NLD)
Jaan Vennik, Tartu Observatory (EST)
Marc Verheijen, Kapteyn Astronomical Institute (NLD)
Barbara Villone, Ossercatorio Astrofisico di Torino (ITA)
Xin Wang, Johns Hopkins University (USA)
Charlotte Welker, Institut d'Astrophysique de Paris (FRA)
Saleem Zaroubi, Kapteyn Astronomical Institute (NLD)
Yi Zheng, Shanghai Astronomical Observatory (CHN)
Ming Zhu, NAOC Beijing (CHN)

Welcome Party

Apéritif punch Yoann à la vanille Bourbon ou kir vin blanc et feuilletés

Vin inclus : Terrasses de Guilhem du Moulin de Gassac

- *Capuccino de tomate au basilic et chèvre frais*
- *Foie gras de canard au pian d'épices*
- *Filet de dorade au sésame*
- *Tartare de saumon à l'huile d'Olives des baux de Provence*
- *Aubergines à la mozzarella et huile de basilic*
- *Tartare de tomate et crème de brousse*
- *Croustillant de chèvre au pistou*
- *Salade d'agneau, crème au romarin*
- *Brochette de poulet aigre douce*
- *Brochette de gambas au piment d'Espelette*
- *Gaspacho andalou*
- *Mini croque au jambon cru*
- *Mini sandwiches*
- *Légumes taillés et anchoïade*
- *Soupe de fruits frais à la menthe fraiche*
- *Mousse au chocolat guayaquil*
- *Pot de crème à la vanille bourbon*
- *Gâteau au chocolat et aux mendiants*

Café

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Banquet

Apéritif
Coupe de champagne et feuilletés
Vin : Mas de Cadenet Côtes de Provence Sainte-Victoire

Entrée
Terrine de chèvre
Aux tomates confites et olives, émulsion de ciboulette

Plat
Filet de boeuf en croûte, caviar d'aubergine
et jus réduit aux olives des baux

Dessert
Minestrone de fruits frais et granité de citron vert
Café

Aix*Marseille université

Conference

COSMIC FLOWS

Observations and Simulations

June 3rd - 7th, 2013 • Marseille, France

Aix-Marseille Université - Faculté des sciences - 3 place Victor Hugo 13331 Marseille

http://cosmicflow13.cpt.univ-mrs.fr

Review of recent developments on

- Measurement of distances and peculiar velocities
- Velocity field constructions and models • Cosmological models

INTERNATIONAL ADVISORY COMMITTEE : *Matthew Colless, Australian National University, Australia* • *Hume Feldman, Univ Kansas, USA* • *Mike Hudson, Univ Waterloo, Canada* • *Yehuda Hoffman, Hebrew Univ, Israel* • *Igor Karachentsev, Special Astronomical Observatory, Russia* • *Renée Kran-Korteweg, Univ Cape Town, South Africa* • *Barry Madore, Carnegie Observatories, USA* • *Adi Nusser, Israel Institute of Technology, Israel* • *Jim Peebles, Princeton Univ, USA* • *Adam Riess, Johns Hopkins University and STSCI, USA* •

SCIENTIFIC ORGANIZING COMMITTEE : *Helene Courtois, Institut de Physique Nucleaire de Lyon, France* • *Olivier Le Fevre, Laboratoire d'Astrophysique de Marseille, France* • *Roya Mohayaee, Institut d'Astrophysique de Paris, France* • *Roland Triay, Centre de Physique Théorique AMU, France* • *Brent Tully, University of Hawaii, USA* •

This conference will also be honoring the career and 70th birthday of

Brent Tully

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