Optical drift effects in cosmology – covariant approach

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In the recent years we have witnessed the emergence of a new field in cosmology, referred to as the “real-time cosmology”, concerned with measuring small temporal changes of positions, redshifts and luminosity distances of objects at cosmological distances. Time variations of these quantities, also known as the optical drift effects, observed over the time of ≈10 years can provide important information about the Universe on large scales and its evolution. These data would be independent from the standard cosmological observables like the CMB power spectrum, the current value of the Hubble parameter or the redshift-luminosity relation for supernovae, and thus could significantly expand our understanding of the Universe.
In my talk I will address the general problem of evaluating the optical drift effects, i.e. the changes of the optical observables, in general relativity. I will present a fully relativistic and covariant approach, in which the problem is reduced to a hierarchy of geometric ODE's solved along the line of sight. The 4-velocities and 4-accelerations of the observer and the emitter and the geometry of the spacetime along the line of sight constitute the input data. The application of the formalism includes both numerical and theoretical cosmology. Additionally we obtain two general, non-perturbative relations: the first one between the gravitational lensing and the apparent position drift and the second one between the apparent position drift and the redshift drift. I will briefly discuss their physical meaning in the context of cosmology.

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