Cosmology in a Nonlocal Metric Realization of MOND

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Milgrom's MOdified Newtonian Dynamics (MOND) provides a wonderful explanation for galactic structure, as shown by the striking recent work of McGaugh and collaborators (arXiv:1609.05917). However, MOND must be regarded as the weak field, static limit of some larger, relativistic field theory, and it is this larger theory which controls MOND cosmology, and also the model's predictions for recently disturbed systems such as the Bullet Cluster. I report on a nonlocal, pure metric realization of MOND which was developed by Deffayet, Esposito-Farese and myself in arXiv:1405.0393. The model is based upon an algebraic function of a nonlocal scalar which is typically positive for gravitationally bound systems, but is typically negative for cosmological settings. Correctly reproducing MOND phenomenology for galaxies therefore determines how the algebraic function depends on positive arguments but does not constrain its dependence on negative arguments. I report on a recent determination (arXiv:1608.07858) of the negative branch which succeeds in enforcing the Lambda CDM expansion history, without dark matter, until very late redshifts ($z < 0.088$). This means that the model agrees with the usual predictions of Big Bang Nucleosynthesis and at least has the same cosmological background geometry as usual during Recombination. Interestingly, the expansion history deviates at very late times in such a way as to reduce the growing tension between inferences of the Hubble parameter based on data from large redshifts and inferences based on data from small redshifts. Because no more freedom exists in the model, its response to perturbations can now be studied to see if it agrees with the observed pattern of Doppler peaks in the Cosmic Microwave Radiation, and also if it is in rough agreement with structure formation.