Oliver F. Piattella
LIST OF KEY PUBLICATIONS

1. O. F. Piattella, *The extreme limit of the generalised Chaplygin gas*, JCAP 1003 (2010) 012, arXiv:0906.4430

In this paper I investigate the large α limit of the generalized Chaplygin gas (gCg), where α is the extra parameter of the model (extra with respect to the ΛCDM model, which is the limit $\alpha \to 0$ of the gCg). It is known that $\alpha < 10^{-5}$ is necessary for structure formation, but in this paper I show that quite unexpectedly the gCg model becomes viable again for large values of α. I also comment on a possible relation with the Cuscuton model, which is an incompressible (i.e. with infinite speed of sound) k-essence field which minimally modifies the cosmological constant scenario giving Dark Energy a dynamics with no extra degrees of freedom when perturbed.

I have selected this publication because was my first one single-authored and was done during my PhD. So, I consider it quite an important step in my career.

2. C. E. M. Batista, M. H. Daouda, J. C. Fabris, O. F. Piattella and D. C. Rodrigues, *Rastall Cosmology and the ΛCDM Model*, Phys. Rev. D85 (2012) 084008, arXiv:1112.4141

We investigate here a modified theory of gravity known as Rastall's theory in which a non-minimal coupling between geometry and matter is considered. The principal effect of this non-minimal coupling is to provide a correction to the usual conservation equation, the divergenceless of the energy-momentum tensor, that we characterize as an effective description of quantum effects in curved spacetime. The main result that we find is that a class of cosmological models based on Rastall's theory are able to reproduce the ΛCDM model results up to linear order but with a clustering Dark Energy (DE) component. The non-linear regime is also investigated, in the special case of the spherical collapse, and in this case differences from the ΛCDM model appear depending on the non-minimal coupling of the theory. This opens the interesting possibility of testing structure formation within Rastall's cosmology, especially in relation with the small-scales issues of CDM.

I consider this publication important because it offers a connection among modified models of gravity and cosmological models with clustering DE, which are intensively studied in contemporary cosmology in connection to the cosmological constant problem.

My contribution in the publication concerned the perturbative study of the model, done in the Newtonian gauge in order to investigate the evolution of the gravitational potential more easily. I also did the analysis of the spherical collapse.

3. O. F. Piattella, *Lensing in the McVittie metric*, Phys. Rev. D 93 (2016) no.2, 024020, arXiv:1508.04763

In this work I tackle the long-standing problem of whether and how cosmology affects the deflection of light. Almost all (all but two, to be precise) the previous works deal with the problem by assuming a Schwarzschild-de Sitter metric, written in static coordinates and thus not properly taking into account the embedding of source, lens and observer in an expanding universe. Instead, I use McVittie metric, which is an exact solution of Einstein equations (found by McVittie in 1933) which merges together Schwarzschild and Robertson-Walker metrics and thus gives, in my opinion, a more realistic framework in which to study the lensing phenomenon on cosmic scales. I limited my investigation here to the case of H constant, i.e. a cosmological-constant dominated universe, in order to make contact with previous works on the subject, but in my subsequent paper on the topic (also the next on this list) I generalize my investigation to a generic time-dependent Hubble factor. My result here is that the cosmological constant does not affect the bending of light at the leading order in the expansion for the deflection angle.

I find this paper important because I take into account the embedding of source, lens and observer in an expanding universe exactly, i.e. using a geometric framework which is an exact solution of Einstein equation which has the correct cosmological limit at large distances from the lens.

4. O. F. Piattella, *On the effect of the cosmological expansion on the gravitational lensing by a point mass*, Universe 2 (2016) no.4, 25, arXiv:1609.00270

As mentioned in the previous item of this list, in this paper I generalize the investigation of the bending of light in the expanding universe to a time-dependent Hubble factor. In this case I find two interesting results: the first is that again the bending angle is not affected by H at the leading order, even if H is time-dependent. The second is that cosmology, i.e. the redshift of the lens and of the source and the Hubble parameters evaluated at these redshifts, enters the next-to-leading order in the expansion of the deflection angle.

I find this paper important because its results suggest a possible connection between strong lensing and cosmology which could allow us to determine the expansion history of the universe, i.e. $H(z)$, from strong lensed systems.

5. O. F. Piattella and L. Giani, *Redshift drift of gravitational lensing*, Phys. Rev. D 95 (2017) no.10, 101301, arXiv:1703.05142

In this work Leonardo (who is my PhD student, co-supervised by Prof. Luca Amendola) and I propose two new effects that will be hopefully soon detected in strong gravitational lensing: the drift of the lensed images and the drift of the time-delays. Both these effects are due to the expansion of the universe, in particular to the redshift drift, and if detectable would provide a direct way of measuring $H(z)$. The main advantage with respect to the detection of the redshift drift effect in itself is that for the time delay drift no spectroscopy is necessary but an accurate timing of the time delays of the lensed sources. This is already being done quite successfully by the COSMOGRAIL and H0LiCOW collaborations (the latter was able to determine the Hubble constant from time delay with a 3.8% precision).

I find this paper important because it suggests a method for determining $H(z)$ from strong lensed systems and hence, if viable, would allow us to reconstruct the expansion history of the late universe, with evident important consequences on our understanding of DE (such as its equation of state, for example). About the viability, the effect that we predict is incredibly small, but we are confident in the increasing development of the observational techniques. The very proposal of Refsdal, who in 1964 suggested to use time delays in order to measure the Hubble constant, seemed hopeless at his time (his paper was cited for the first times thirty years later!) but it is now an amazing reality.