The Dark Side of Gaia: testing dark matter and alternative gravities with our sharpest instrument

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ESA's Gaia satellite, just launched in december 2013, is performing astrometry and photometry measurements of more than 1 billion objects up to a magnitude V~20, as well as spectrosocopy for some 150 million objects up to V~16. The mission will be completed with ground-based spectroscopic surveys, such as 4MOST and WEAVE, for stars with 16<V<20. Complementary all-sky photometric surveys are also being prepared, including the *Luau* concept to map the *u*-band sky that the Observatoire Astronomique de Strasbourg is proposing.

Although there will be a plethora of science topics addressed by the Gaia mission, its primary objective will be to provide a detailed mapping of the Galaxy's gravitational potential (see Famaey 2012). This will allow for the first time to test with exquisite precision various models of dark matter distributions as well as alternative theories of gravity. The number of probes of the Galactic potential will be numerous, and one of them will be the dynamics of stellar streams orbiting around the Galaxy.

Typically such streams orbit at large galactocenric distances where alternative theories of gravity predict significant deviations from Newtonian dynamics, but due to the complex nature of tidal disruption in such alternative theories, the precise differences are still unclear.

The Observatoire Astronomique de Strasbourg is the ideal place to carry on a study of the differences between Newtonian models including a dark matter component and such alternative theories for stellar streams due to our unique expertise in studying alternative theories of gravity (Benoit Famaey) as well as streams (Rodrigo Ibata).

The present project would rely on the hydrodynamical code RAMSES which has recently been adapted by Famaey and colleagues in Bonn, to work in modified gravity (e.g., Lüghausen et al. 2013), as well as on the stream-fitting code of Varghese, Ibata & Lewis (2011). The present project will involve an important collaboration with the Helmholtz-Institut für Strahlen und Kernphysik in Bonn (Pavel Kroupa). An initial Gaia catalogue will be released in 2016, and we expect that this data in conjunction with ground-based surveys will be sufficient make new stream discoveries and constrain better those that are already known. It will also be necessary to construct mock data with Gaia-like precision, using cosmologically-motivated galaxy models to test expectations. The aim is to have in place a powerful tool by the end of the Gaia mission to make the definitive measurements of the dark matter content and distribution of our Galaxy.

[1] Famaey, B., SF2A proceedings, p.15, arXiv:1209.5753 (2012)
[2] Lüghausen, F.; Famaey, B.; Kroupa, P.; et al. MNRAS, 432, 2846 (2013).
[3] Varghese, A.; Ibata, R.; Lewis, G. F. MNRAS, 417, 198 (2011)