Contribution ID: **15** Type: **not specified**

Exploring electromagnetism in the Standard-Model Extension: theory and satellite data analysis

Monday, December 5, 2022 3:30 PM (45 minutes)

The photon is the dominant astro-particle as astrophysical observations are largely based on electromagnetic signals still read with the Maxwellian massless and linear theory, possibly an approximation of a larger theory, as Newtonian gravity is for the Einsteinian gravity in weak fields. Apart from massive (de Broglie-Proca, Bopp, Podolski, Stueckelberg and others) and non-linear (Born-Infeld, Euler-Heisenberg and others) formalisms, the Standard-Model Extension (SME) dresses the photon of a mass dependent from the Lorentz-Poincaré symmetry violation. Extended Theories of Electromagnetism (ETE) lead to surprising options for reading the universe as challenges to the ΛCDM cosmology. The SME induces deviations from the Ampère-Maxwell law, by means of an extra-current. We have sought in six years data of the Magnetospheric Multi-Scale (MMS) mission, a four-satellite constellation, crossing mostly turbulent regions of magnetic reconnection and collecting about 95% of the data outside the less turbulent region of the solar wind. We examined 3.8 million points, at each of which we collected 82 parameters from the solar wind, magnetosheath and magnetosphere regions. In a minority of cases, (only 2.2% in modulus and 4.8% in Cartesian components for all regions, but 21% in modulus and 29.9% in Cartesian components in the solar wind), deviations have been found. New analysis or future satellite measurements may clarify the nature of these deviations, whether unaccounted errors or glimpses of new physics. Possibly, we are confronted with the limit of non-dedicated experiments. We mention more stringent but model-based limits. These is an informal collaboration on theory, observations and experiments with CERN-King's College London, Univ. Bremen, Univ. Napoli, UERJ and CBPF Rio de Janeiro, IAC Tenerife and other institutes.

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