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Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions (2)

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LAGRANGE: A PROPOSAL FOR FUNDAMENTAL PHYSICS IN SPACE

Abstract

The Lagrange points of the sun-earth pair constitute an almost rigid frame accompanying the earth on its orbit around the sun. This feature and the size of the whole system make them appropriate for important measurements of fundamental physics. In particular, if transponders and emitters were located in the Lagrange points (excluding L_3 on the other side of the sun with respect to the earth) it could be possible to perform a Sagnac-like experiment sending electromagnetic signals along a closed contour, in opposite directions. The expected time of flight difference would be a check of the solar gravito-magnetic field and would allow for a measurement of the angular momentum of the sun. Such information would give hints to reconstructing the internal structure of the star. Another important result obtainable using a frame at the scale of the orbit of the earth would be the detection of a dark galactic gravito-magnetism. In fact if a massive halo of dark matter exists incorporating the galaxy, since it interacts gravitationally with the visible matter, it must necessarily rotate. Then it possesses a relevant angular momentum and consequently produces a gravito-magnetic field bigger than the one due to the ordinary matter. The flux of such field across a loop having at the corners the Lagrangian points (for example a $L_4 - L_2 - L_5$ triangle) could produce a detectable asymmetry in the times of flight of electromagnetic signals superposed to the kinematical effect of the orbital motion. An additional interesting possibility offered by emitters located at the Lagrange points would be to use them as the basis of a relativistic positioning and navigation system at the scale of the solar system. In fact the emitters would work as artificial pulsars. Pulsars can indeed be used for positioning and navigation since they are extremely good clocks and occupy almost fixed positions in the sky; the inconvenience is however the extreme weakness of the signals. In the case of the Lagrangian frame, the positions of the emitters would be fixed with respect to the earth and the intensity of the signals could be much bigger than in the case of pulsars. The method to be used for relativistic positioning would be based on local measurements of the arrival times of the pulses from the Lagrangian emitters.