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TIMING TECHNIQUES APPLIED TO DISTRIBUTED MODULAR HIGH-ENERGY ASTRONOMY: THE HERMES PROJECT

Abstract

The revolutionary concept of distributed (modular) space astronomy represents the key to investigating the unknown of the Universe. Indeed, from a very general point of view, the greatest advantages for a cutting-edge (Astro)physical space science stem from the possibility of using extremely powerful astronomical events as (Astro)physical laboratories to explore energies unattainable in ground-based laboratories. On the other hand, a high number of photons from these (Astro)physical laboratories need to be collected to attain the accuracies required, demanding progressively larger collecting areas. The key idea of this exciting research field is to distribute astrophysical detectors over a fleet of nano/micro/small-satellites to achieve huge overall collecting areas, which otherwise would be unreachable with a single instrument and impossible to carry with the current rocket load capabilities. A possible realization of this mission concept that could be quickly developed over the next 5 to 10 years is a "distributed" high-energy all-sky monitor with a good temporal resolution with the aim to detect and accurately locate transient X-ray events by means of temporal triangulation. Ideal targets of this observatory will be transient sources such as Gamma-Ray Bursts (GRBs), galactic X-ray transients, high-energy counterparts of Fast Radio Bursts as well as periodic sources like X-ray pulsars. For example, the study of GRBs, in conjunction with the Gravitational Interferometers, will allow the development of the newly born multi-messenger astronomy from infancy to maturity. Moreover, they could be used to set up precise tests of Quantum Gravity theories that predict a dispersion law for photons. Here I will discuss in detail dedicated timing techniques that will allow us to precisely locate astronomical events in the sky taking advantage of the spatial distribution of a swarm of detectors orbiting Earth. More specifically, I will apply these techniques to the HERMES Technological and Scientific pathfinders currently under development that consist of a fleet of six 3U CubeSats to be launched in equatorial Low Earth Orbits by the end of 2022.