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# Gamma-ray Transient Network Science Analysis Group

*A SAG from the Physics of the Cosmos Program Analysis Group*

The InterPlanetary Networks (IPN) have been key to scientific discovery and international relations in the realm of high-energy time-domain science. These IPNs are comprised of gamma-ray instruments on satellites in low earth orbit and on planetary spacecraft, allowing for sufficient baselines to triangulate short-duration transients. Triangulation of gamma-ray bursts identified gamma-ray bursts and proved their astrophysical origin. The first and second IPNs provided the first evidence for their cosmological origin and also discovered magnetars by isolating soft gamma-ray repeater flares as a new event class. We are currently on the Third IPN which proved extragalactic magnetar giant flares as a source of gamma-ray bursts, has helped isolate ultra-long gamma-ray bursts, is the preeminent source for soft gamma-ray repeater flares, and provides the only continuous full-sky coverage for externally identified transients including gravitational waves.

The sources of signals discovered by the IPN are short-duration transients in the gamma-ray regime, emit radiation across the electromagnetic spectrum, and include known or potential multimessenger sources. The IPN is thus a key component of the time-domain and multimessenger program recommended in *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*. Many countries are now developing and launching gamma-ray cubesats and smallsats to low-Earth orbit to contribute to this new era of astronomy. However, the Third IPN relies on instrumentation designed for other purposes (such as planetary surface spectroscopy), and the IPN has always operated with United States scientists playing a leading role and with collaborators in numerous countries, including the Soviet Union during the Cold War. After nearly 50 years of discovery, the future of the IPN in the US is uncertain. The goal of the proposed SAG would to be analyze and answer the following questions:

1. What time-domain and multimessenger sources rely on the InterPlanetary Network? What scientific discovery will the IPN enable? How does it fit into the new astrophysical landscape? What would be lost if the IPN ends? How does the science case for IPN depend on interplanetary probes and the long baseline they provide?
2. Where can improvements be made to the existing IPN? What are the needs of the full astronomical community, especially the needs of those who study fast radio bursts, optically-identified relativistic transients, the gravitational wave community, and the neutrino community? How can we make use of advances to the Global Coordinates Network, and how do IPN alerts need to be improved? What are the needs of the international gamma-ray satellite community? Would engagement between these new satellites and the IPN benefit the astrophysical community? Would greater integration bring greater benefits?
3. What benefits would extending the IPN beyond the current gamma-ray instruments bring? What future missions and instruments are needed to fully realize the Decadal-recommended science in partnership with the advancing capabilities in other wavelengths and other messengers?

To address these questions in a timely manner in order to understand the optimal use of our existing facilities in response to the 2020 Decadal survey and to support the IPN for the next gravitational wave observing run, we propose a new Gamma-ray Transient Network Science Analysis Group (SAG). This SAG would have open membership, including volunteers from PhysPAG, with Eric Burns as Chair, and the broader scientific community, with Michael Coughlin to be Co-Chair, with the goal to analyze the above questions and compose and publish a report, delivered to NASA HQ, in December 2022.