Components of the one-page proposal summary

Need/research lacuna: Understanding the origin of Cosmic Rays, the composition of astrophysical Jets and of High Energy neutrinos observed by neutrino telescopes is one of the biggest mysteries in Astrophysics. Powerful jets launched following core collapse occasionally produce gamma-ray bursts that temporarily outshine the entire universe in gamma-rays. However, a substantial fraction of jets created by dying stars may never make it out of the stellar envelope. The proposed research will establish the early observational signatures and strategies for the multi-messenger observations of such hidden jets.

Research objectives: The main objective of the proposal is to explain the nature of astrophysical jets and the origin of high energy cosmic rays and neutrinos with the help of multi-messenger observations. The project will focus on two signatures in particular: fast ultraviolet observations with the future rapid-response, wide-field-of-view ULTRASAT satellite, which will be able to record radiation from the breakout of the shock created by the submerged jet; and high-energy neutrinos which can escape from the depths of the stellar envelope, carrying information on optically inaccessible processes.

Methodology: The work will establish the expected detection rate with ULTRASAT of breakout radiation due to hidden jets as well as those of other UV transients that need to be distinguished. It will determine the precision with which explosion and jet properties can be reconstructed from UV and multi-messenger observations. Finally, the research developed a rapid follow-up observation strategy of high-energy neutrinos for ULTRASAT and estimated the required observing time to optimally search for hidden jets. The project will combine the multi-messenger observational expertise of the U.S. team with the experience and leadership of the Israeli team of the ULTRASAT satellite.

Expected significance/contribution: Discovering hidden jets may be the key to deciphering some of the key open questions in astrophysics today. These questions include the origin of high energy cosmic rays, the origin of the observed cosmic neutrino background, how jets are launched by accreting black holes, and how collapsing stellar cores explode creating supernovae. The research will advance an emblematic inquiry of the multi-messenger era: the combined analysis and interpretation of electromagnetic radiation and high-energy neutrinos. The award will cultivate new multi-messenger and astroparticle collaborations and expertise that will bolster ongoing research and enhance further investigations.