STARKEY – Solving the TP-AGB STAR conundrum: a KEY to galaxy evolution

Models of the Thermally Pulsing Asymptotic Giant Branch (TP-AGB) stellar evolutionary phase play a critical role across astrophysics, from the chemical composition of meteorites in the pre-solar nebula up to galaxy evolution in the high-redshift Universe. In spite of its importance, the modelling of TP-AGB phase is still affected by large uncertainties which propagate into the field of extragalactic astronomy, degrading the predicting power of current population synthesis models of galaxies. The major goal of my proposal is to remedy this persistent condition of uncertainty and controversy. The solution to the TP-AGB star conundrum will be provided by a new approach, which builds on the combination of a) state-of-the-art theoretical tools to account for the extraordinarily complex physics of TP-AGB stars (evolution, nucleosynthesis, pulsation, winds, dust condensation and growth, etc.), and b) exceptionally high-quality observations of resolved TP-AGB stellar populations in stars clusters and nearby galaxies (Magellanic Clouds, M31, dwarf galaxies up to 4 Mpc) with reliable measurements of their star formation histories. We will adopt a global calibration method, in which TP-AGB evolution models are required to simultaneously reproduce a set of well-defined observational constraints (star counts, distributions of luminosities, colors, pulsation periods, dust mass-loss rates, expansion velocities of dusty envelopes, etc.). This project will deepen our understanding of TP-AGB physics profoundly, and provide widespread community benefits as well. We will publicly release well-tested and reliable ``TP-AGB deliverables'', including stellar tracks, isochrones in all relevant photometric systems, extended libraries of stellar spectra, new wind and pulsation models for long period variables, and chemical yields for both gas and dust. Eventually, these products will be embedded in the stellar population synthesis models which are routinely used to analyze the integrated galaxy observables that probe the extragalactic Universe. The project is extremely challenging and is expected to produce massive breakthroughs in various branches of astrophysics.

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