Thesis subject

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Subject's title: Massive Stars in Low Metallicity Environments

Subject description:
Massive stars (above 8 solar masses) have played a crucial role in the Universe throughout cosmological time. They have a dramatic effect on the appearance, composition and dynamics of galaxies from the time of reionization to the present day. Massive stars eventually form a degenerate core and collapse down into a compact object, either a neutron star or a black hole. Most of them, either single or binaries, end their lives in luminous explosions as core-collapse supernovae; a fraction of these events produce Long Gamma-Ray Bursts (LGRBs) that enable us to probe the distant Universe. Binary neutron star systems, the offsprings of binary massive star systems, can also produce Short Gamma-Ray Bursts (SGRBs), such as the one associated with the last gravitational waves detected by LIGO. Understanding the lifecycle of massive stars thus lies at the core of a wide variety of topics in Astrophysics.

Despite many theoretical and observational studies, no global consensus has been achieved yet, on the details of the evolution and properties of massive stars with solar-like metallicity. Of greater concern is that the same processes at low metallicity are even more uncertain. Understanding stellar evolution at low metallicity is indeed crucial for understanding early galaxy evolution since the Universe began with zero metals. Therefore, any description of massive stars aiming to be comprehensive must assess the role of chemical composition on their properties, evolution and fate, in order to understand the conditions of earlier cosmic epochs, and to ultimately extrapolate the prescriptions for physical properties to the time of re-ionization.

The central theme of this thesis is to explore the properties of massive stars in metal-poor environments, namely the Magellanic Clouds and other Local Group galaxies with typically 10% of solar metallicity. This work will rely on synthetic spectra computed from state-of-the-art model atmospheres, as they allow to draw accurate inferences on the structure, evolution, and the associated radiation of massive stars, by connecting the output from evolution model calculations to observations.

Therefore, we are seeking for a candidate interested in one or more of the following fields: spectroscopic analysis, stellar evolution, numerical simulations.

This thesis work will be performed in close collaborations with colleagues at Pittsburgh University, Trinity College in Dublin, and Geneva Observatory, that the student will be encouraged to visit. The stellar atmospheric and evolutionary properties will be investigated with state-of-the-art tools for these complex calculations, namely the CMFGEN code for model atmosphere, and the Geneva code for evolutionary models, of which we have ample expertise. The thesis is an essential prerequisite to properly tackle the next milestone in the road to more primitive stellar populations and galaxies in both the high redshift and local Universe, or to address the tantalizing question of the gravitational wave source progenitors.

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