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The physics of the metallicity dependent IMF

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Understanding what sets the stellar initial mass function (IMF) in diverse environments remains a critical but unanswered question in astrophysics. The mass of stars that form is closely linked to the thermodynamics of interstellar gas, which controls how gas fragments as it collapses under gravity. As the Universe has grown in metal abundance over cosmic time, this thermodynamic behaviour has evolved from a primordial regime dominated by molecular hydrogen cooling to a modern regime where the dominant process in dense gas is protostellar radiation feedback, transmitted to the gas via dust grains. In this talk, I will present results from a suite of semi-analytical models and high resolution radiation-magnetohydrodynamics simulations that self-consistently include non-equilibrium
chemistry, radiation feedback, and magnetic fields to construct the IMF at different
metallicities from first principles. I will show that the transition in the IMF from the primordial regime to the modern regime begins at metallicity Z ~ 0.0001Z, passes through an intermediate stage where metal line cooling is dominant, and then transitions to the modern dust- and feedback dominated regime at Z ~ 0.05Z. This transition is accompanied by a dramatic change in the peak IMF mass, from ~50 Msun at Z ~ 10^(−6) Z to ~ 0.3 Msun once radiation feedback begins to dominate, which marks the appearance of the bottom-heavy Solar neighborhood IMF. I will close by providing
some predictions for the IMF and its sensitivity to chemistry in low metallicity ISMs that will be tested by ongoing JWST observing programs.

Primary author: SHARDA, Piyush (Leiden University)

Presenter: SHARDA, Piyush (Leiden University)

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