Contribution ID: **67** Type: **Contributed talk**

A 'low' redshift mode of Population III star formation during the Epoch of Reionization

Thursday 8 May 2025 11:40 (20 minutes)

Thanks to JWST, we are now in an era where observing campaigns to discover Population III stars has become a possibility. Over the past 3 years, multiple JWST proposals on Pop III stars have secured time, but no definitive detections have emerged. The two most pertinent challenges are: 1.) if most Pop III stars were massive, they would have not survived for a time window long enough for JWST to capture them, and 2.) if they formed at redshifts > 15, which even with the sensitivity of JWST remains notoriously hard to observe. Recent works suggest that Pop III star formation could have continued down to 'low' redshifts, during the Epoch of Reionization (EoR, z ~ 6). If realistic, this could be a game changer since the natural expectation is that such Pop III stars would have been less massive, lived to a longer time period, and are located at cosmological distances within the reach of JWST. Motivated by these possibilities, we carry out the first 3D radiation magnetohydrodynamics simulations of Pop III star formation during the EoR. We find significant differences in the mass, multiplicity, radiation and cluster properties of Pop III stars between z = 6 and z > 15. Contrary to expectations, even though the gas is colder at z = 6, there is less fragmentation within the pristine cloud due to the combined effects of magnetic fields and radiation feedback. Differences in protostellar accretion rates at z = 6 and z > 15 lead to very distinct stellar evolution, which changes the amount of ionizing and dissociating photons produced, and subsequent escape fractions. The differences are even more dramatic when a background Lyman-Werner radiation appropriate at z = 6 is included. By providing realistic, full physics-guided estimates of the mass and radiation properties of these stars, our simulations provide much needed benchmarks for designing Pop III observing campaigns with JWST towards the end of the first billion years.

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Session Classification: Session 5