ENIGMATIC FIRST STARS AND WHERE TO FIND THEM

IFPU Focus Week

May 15-19, 2023

WRAP UP & FINAL DISCUSSION

Theoretical models of stellar evolution:

- yields predictions are dependent on many parameters which are difficult to constrain at the moment. Complete evolution in 2D (or 3D) is not possible to simulate at the moment (Limongi, Ekström, Kobayashi, Costa, Volpato)
- The odd-even effect is probably the most solid prediction distinguishing zero metallicity stars from more enriched ones, this is true in particular for PISN (Limongi)

Theoretical models of chemical evolution/Cosmological simulations:

- Some constraints on the properties of first stars have been obtained, however these constraints in many cases depend on the chemical yields (Salvadori, Cescutti, Matteucci)
- From cosmological simulations, star formation from PopIII appears to be generally sub-dominant after a very short initial phase, however PopIII could still exist down to intermediate redshifts (z~4) (Pallottini, Maio, Katz)

Observations:

- Many observations will be obtained in the next 3-5 years on local metal poor stars (Aguado, Skuladottir)
- Also large surveys of quasars that could be used to identify extremely metal poor DLAs (if they exist) and LLs (Berg, Welsh, Saccardi)
- GRBs can potentially probes first stars' enriched gas and explosions of first stars but timescales are long (Vergani)
- JWST is observing objects with peculiar spectra and could possibly observe PopIII stars (Ferrara, Vanzella, Bradac, Zackrisson)

WRAP UP & FINAL DISCUSSION

After this meeting, which request would you make to theoreticians/observers that could help improving the knowledge of first stars?

My question to observers would be: Please, observe a statistically significant number of CEMP-no!

What is the best way to experimentally constrain the PopIII IMF?

Which spectral signatures observable in high-z galaxies would convince you that we are indeed looking at Pop III stars?

An essential thing that theoreticians could try to do is to compare all the Pop. III models available in the market. This work could help in providing theoretical predictions with correlated errors.
It is very important to constrain the uncertainties on the most important physical processes that impact stars' evolution and discuss the calibrations adopted for each process.

My request to observers would be to exploit at maximum the new generation of spectroscopic surveys. To the theoreticians, I'd say we need to have evolutionary models reproducing what we see in the MW and other smaller systems in the very metal-poor end of the MDF (i.e. at earlier times), if possible!

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How do we connect the evidence of the first stars in the local Universe with those in the high-z Universe?

Should the existence of the high-z blue monsters detected by JWST change our view of the Milky Way formation?

We require better constraints on the physical properties (rotation, mass, explosion energy) of first stars for better yields. Maybe this requires novel methods for observing these, or better understanding of systematics in predicted yields.

In an ideal world we have more access to rarely-detected, yet apparently critical, elements in absorbers/stars. Is ELT/ANDES the answer?

To theoreticians: What's the best redshift to find PopIII? If we detect ongoing star-formation at z=20 (or 30) can we say that the fraction of PopIII is (necessarily) already large? (100-300 Myr after the BB)

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For theoreticians to predict errors on pop III and pop II yield calculations based on uncertainties/assumptions. For observers to detect more odd-even elements in absorbers.

I would ask to observers for improvements in the metallicity and element to element abundance constraints about stars allegedly influenced by pop III stars' pollution (data coming in mentioned by Asa today). In this way theoreticians could try improving the models of these elusive stars.

What's the typical stellar mass and luminosity we expect for a PopIII star/complex?

What're the typical spatial scales and environments we need to explore? Or is it better to avoid any pre-selection and just perform blind search?

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To theoreticians: If we detect pristine stars at z>10 (e.g. a system with prominent Balmer and Helium lines and a complete absence of any metal lines), what's the most informative quantity you would need? Or you want to extract?

What progress in the field would bring the detection of a zero metallicity star with mass ~0.7 Mo?

Do we really care about PopIII stars for chemical and galaxy evolution?

(The answer is YES. In particular, they are important to understand for stellar evolution and also for the fornation of SMBH that we see at very high-z)