Contribution ID: **11** Type: **not specified**

Universal Blacksmith: What Metals Reveal About the Histories of Galaxies

Tuesday, 30 July 2024 09:30 (30 minutes)

As increasingly more detailed observational data allows the probing of multiple metal lines in both stars and gas, a new window has opened into understanding the formation and accretion of galaxies' stars. In particular the ratio of alpha-elements such as oxygen and magnesium to iron contain information about the amount of enrichment from faster acting supernovae type II versus slower acting type Ia. Using the hydrodynamical cosmological simulation Magneticum Pathfinder I probe the evolution through cosmic time of different metals both locked into stars as well as within the gas of galaxies. I show how [alpha/Fe] and the stellar mass can constrain the galaxies' formation redshift, how the contribution of SN type Ia rapidly rises until z~1 before saturating, and also how individual galaxies evolve in the [alpha/Fe] vs [Fe/H] plane. Finally, I discuss where the observed high [alpha/Fe] at cosmic dawn originate from and how these earliest galaxies reach super-solar metallicities so quickly.

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