Nucleosynthesis in black hole accretion disks: a channel to form 2P stars in globular clusters?

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Abstract

Considered as a prototype of simple stellar populations for a long time, globular clusters are now known to host multiple stellar populations. Two main groups have been identified: the "1P stars", with pristine chemical abundances, and the "2P stars", showing enhancement in N, Na, and Al together with depletion in C, O and Mg. The observed abundance trends are consistent with the activation of the CNO cycle, NeNa and MgAl chains. Many theories have been suggested to shed light on the origin of these chemical peculiarities, most of them involving a mixing between pristine and "enriched" material coming from different polluter. Yet, none can reproduce all the observations (see [1] for a complete review), and the puzzle on the origin of multiple stellar populations remains currently unsolved.

Black hole accretion disks were suggested [2] as a possible source for the polluted material. Through energetic processes (outflows), this material can be ejected and can mix with pristine material, originating 2P stars. Using the nuclear reaction network TORCH [3], we performed a detailed exploratory study to identify the parameter space giving rise to the right correlations and anti-correlations between chemical elements. We find that under realistic conditions of temperature, density, exposure time and initial chemical abundances, Na, N and Al are enriched while O, C and Mg are depleted. We compare our results with observations of NGC 6742 and show that, by using different mixing weights between pristine and polluted material, we can recover the broad range of observed abundances.

References

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