Super star clusters and their multiple stellar populations

Zinnecker H.

We present a scenario for the formation of super star clusters (with masses larger than 105 Mâ?) in which multiple generations of star formation will occur. We stress that the gas left over (?50%) from first generation (1G) star formation should be retained in such massive clusters (thanks to their deep potential wells, with escape speeds larger than 10 km/s) and be available for a second or even third generation of stars, with the basic HeCNONaMgAl chemical anomalies observed in globular clusters, the latter assumed to be the descendents of these super star clusters. One new feature of this model is the role of C+ cooling of the dense warm trapped neutral or ionized gas which defines a characteristic temperature of ?100 K, leading to a second generation (2G) of stars with a top-heavy IMF (M > 5 Mâ?). The ashes of the 2G very massive stars (VMS, M > 100 Mâ?) sampled in this IMF quickly pollute and dilute the left-over pristine gas with their slow winds (that cannot escape the cluster), while the majority of massive stars develop fast winds (that actually can escape from the cluster). Meanwhile, much of the remaining dense T = 100 K gas contracts gravitationally in the massive cluster and may reach densities of the order of 109 cm-3, in which case the Jeans mass drops to about 0.2 Mâ? and leads to a substantial low-mass pre-MS 3G population (most likely on a very short timescale). In this way, we may solve both the mass budget and the excess Helium problem in proto-globular clusters, while also explaining the Na-O and Mg-Al anti-correlations resulting from hot H-burning of very massive stars at 45MK and 75MK, respectively.

globular clusters

multiple stellar populations

star clusters

star formation