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rmaa@astroscu.unam.mx
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Román-Zúñiga, C. G.

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THE ROLE OF ENVIRONMENT IN THE FORMATION OF STAR CLUSTERS

C. G. Román-Zúñiga [1]

The formation of star clusters is nowadays understood as a process that depends strongly on the initial conditions. Current discussions, however consider that clusters might be one among a wide spectrum of modes of star formation (Bressert et al. 2010, de Grijs, 2012) where the cluster is a product of a number of environmental conditions, like the structure of the cloud, or the influence of massive star associations.

For instance, recent studies of the cluster Barnard 59 (B59), located in the only star forming clump of the closeby Pipe Molecular Cloud have shown that it contains only 14 members, all with masses below 3 $M_\odot$ formed over a period of 2.6±0.8 Myr (Covey et al., 2010) in an environment free of massive stars. The B59 molecular has kept collecting 20 $M_\odot$ since then, and it is in the verge of forming one more source (or system) without showing intentions of fragmenting further (Román-Zúñiga et al., 2010, 2012). In the absence of massive member companions, magnetic fields and feedback are may be the dominating processes that shape the history of star formation (Bailey & Basu, 2012).

However, small, isolated clusters like B59 may not be the norm. Clusters are rather formed in groups. One well studied example of this is the Rosette Molecular Cloud (RMC) where one young OB association (NGC 2244) is surrounded by a family of embedded clusters (see Román-Zúñiga & Lada, and refs. therein) The original hypotheses of sequential star cluster formation from NGC 2244 across the RMC has, however, being trumpled by evidence the formation of these clusters have progressed across the cloud by following its primordial structural conditions, rather than by the influence of the OB association (Román-Zúniga et al. 2008, Ybarra et al. 2013).

We are planning to release soon, a few more studies that provide some additional insight into this problem. In one of them, we study another star forming complex: W3. This region also presents an interesting layout, where the young open cluster IC 1795 is surrounded by two regions of recent formation: to the West, W3-Main, a massive embedded, highly structured cluster, and to the East W3(OH), a smaller episode, also with strong evidence of structuration (Rivera-Ingraham et al. 2012). A combination of data, from optical (IPHAS) infrared (CAHA 3.5m JHK, Spitzer, Herschel) to radio (ARO 12m) and X-Ray (Chandra) help us to reconstruct what appears to be a different type of cluster forming history, in which IC 1795 is indeed, the older episode, with a rapid release of its parental gas, but its age spread of formation (as revealed by the high number of Class II stars) is not really that different from that of its surrounding regions (Román-Zúñiga et al., in prep.)

Similar, multi-wavelength analysis techniques are helping us to study the larger family of embedded clusters of Cygnus-X, one of the most prominent star forming regions of the Galaxy. Clusters DR-15 and DR-17 are excelent starting points. The first one reveals the process of formation of a cluster on a gas pilar, with a slowly evaporating envelope, while the second shows a more classical layout of a central cluster proceding to form a second generation in a surrounding shell (Rivera-Gálvez et al., Maucó et al., in prep). The comparative analysis of all embedded clusters in Cygnus-X will be key to understand cluster formation in an extreme environmental layout.

[1]Instituto de Astronomía, Universidad Nacional Autónoma de México, Unidad Académica en Ensenada. Km. 103, Carr. Tijuana-Ensenada, Ensenada 22860, México. (croman @astro.unam.mx).

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