Two mass distributions in the L1641 molecular clouds: the Herschel connection of dense cores and filaments in Orion A

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Abstract

We present the Herschel double reddening survey (André et al., 2010) maps of the L1641 molecular clouds in Orion A. We extracted both the filamentary and dense cores in the region. We identified when our dense sources were pre-stellar and studied their association with the identified filaments. We find that although most (91%) of the pre-stellar sources are located within or very close to the identified filaments, there is still a significant fraction of sources not associated with such structures. We find that these two populations (on and off the identified filaments) have distinct mass distributions. The mass distribution of the sources on the filaments is found to peak at $M_{\mu}$ and drives the shape of the CMF at masses lower than $4M_{\odot}$ and with a flattening of the CMF at masses lower than $3M_{\odot}$. We conclude that the most massive objects have lower than $6M_{\odot}$ due to the higher proportion of gas that is available in the filaments, rather than in the diffuse clouds.

Main Text

Dense Sources

We use CuTEx (Molinari et al. 2001) to detect and extract the sources individually from each band. We keep only those with a $S/N$ higher than 5, and we merge the five catalogues following Elia et al. (2010). We select only sources that are found in three consecutive bands and higher than 5. We merge the five catalogues following Elia et al. (2010). We use CuTEx (Molinari et al. 2001) to detect and extract the sources individually from each band. We accept only sources with a $S/N$ higher than 5. We merge the five catalogues following Elia et al. (2010). We select only sources that are found in three consecutive bands and higher than 5. We merge the five catalogues following Elia et al. (2010).

Filaments

We identify the filamentary regions on the column density map by means of algorithms for pattern recognition that start from the second derivative of the map, computing the eigenvalues of the Hessian matrix in each pixel and select the regions where the curvature along one of the eigendirections exceeds a certain threshold value. In such an approach the threshold defines the minimum separation in the filamentary region. The method is supposed to separate a filamentary region from its surrounding. Afterwards, morphological operators are applied to determine the central pixels of the identified regions (Schisano et al., in preparation). We plot the identified filaments in Figure 2.

We find that the filaments cross L1641 have an average width of $0.25\,\mathrm{pc}$, comparable to what Arzoumanian et al. (2011) find. Their lengths vary from $0.5\,\mathrm{pc}$ to $10\,\mathrm{pc}$, while their temperatures are generally lower than $10\,\mathrm{K}$, and their mass range from $3M_{\odot}$ to $100M_{\odot}$, note that all filaments have extinction higher than $5\,A_{V}$ and most exhibit region with extinction in excess of $20\,A_{V}$.

Discussion

As there is a significant difference of column densities between the filaments and the rest of the L1641, we have calculated their masses using the recent models of Padoan & Nordlund (2002). We find that 321 of our starless sources can be classified as single core pre-stellar bound objects. The two distributions are found to peak at two different masses; one at $1.0\,M_{\odot}$ and the other at $1.8\,M_{\odot}$, comparable to what Arzoumanian et al. (2011) find. Their lengths vary from $0.5\,\mathrm{pc}$ to $10\,\mathrm{pc}$, while their temperatures are generally lower than $10\,\mathrm{K}$, and their mass range from $3M_{\odot}$ to $100M_{\odot}$, note that all filaments have extinction higher than $5\,A_{V}$ and most exhibit region with extinction in excess of $20\,A_{V}$.

Conclusions

We find that there are two separate mass distributions of the pre-stellar sources located on and off filaments. As filaments have higher column densities than the rest of the cloud, objects formed in the filaments have a larger reservoir of mass to accrete from, forming in general higher mass objects, than those off them. In other words, the dense cores may form in the same general way but in different environments. We find that the completeness limits for both distributions, thus leaving the main result unaffected.

References