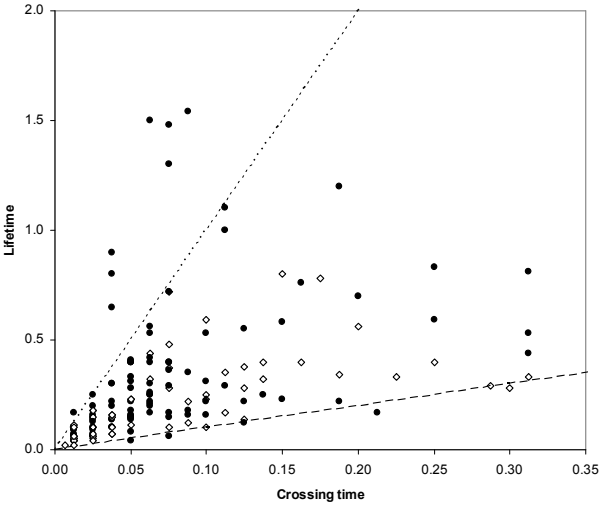

Fig. 3. Clump lifetimes given in terms of the sonic crossing time. Dashed line corresponds to $t_{\rm life} = t_{\rm cross}$ and dotted line corresponds to $t_{\rm life} = 10t_{\rm cross}$. (extracted from Falceta-Gonçalves & Lazarian 2011).

and the disruption of cloudlets and cores. How long can a star forming region survive?

From the fragmentation theory for star formation, a large molecular cloud gets gravitationally unstable and contracts. During the contraction its density gets larger and larger resulting in a decrease of the Jeans mass. Parts of this cloud with masses larger than the new critical mass "dettach" from the whole cloud and starts to collapse by its own. The process occurs until the optical depth of the cloud becomes much larger than unity. The last fragmented cores represent the final stage of a prestellar cloud. The fragmentation and collapse of a cloud is, in general, believed to be fast. Much faster than other typical timescales of the system. Indeed, the ratio between the free-fall time and the turbulent turnover timescale for a Giant Molecular Cloud (GMC) is:

$$\frac{t_{\rm ff}}{t_{\rm turb}} \simeq \frac{c_{\rm s}}{l(G\rho)^{1/2}} \sim 0.1. \qquad (1)$$

However, a typical 1pc sized dense core within a molecular cloud presents $t_{\rm ff}/t_{\rm turb} \sim 10$, i.e., the turbulence is able to fully develop during the core collapse. In order to test the survival of clumps to the turbulent diffusion we performed a standard, 512^3 resolution, 3D MHD numerical simulation with $M_{\rm s} \sim 7$, and identified and followed clumps for a long time. In Figure 3 we present the core lifetimes vs the sonic crossing time for all identified overdensity structures (clumps) in the run. It is clear that most of the detected clumps survive more than one crossing time, but only few can survive more than 10 crossing times (similar to the values found by Galván-Madrid et al. 2007). The turbulent diffusion is able to disrupt a clump before it fragments and collapses even further. Less than 5% of the clumps presented lifetimes larger than 10 crossing times. This result presents a possible explanation for the decreased star formation efficiency, even in regions where there is no massive star or any other source of strong radiation.

A rough estimate of the clump lifetimes is obtained assuming that all the gas shocking on a clump, with size l and density ρ_l, is trapped:

$$\rho v_{\rm L} t_{\rm life} \sim \rho_l l, \qquad (2)$$

where $v_{\rm L}$ is the large scale velocity and ρ is the density of the unperturbed gas. This results in:

$$t_{\rm life} \sim \frac{\rho_l l}{\rho v_{\rm L}}. \qquad (3)$$

Equation 3 shows that the lifetime of a small scale clump depends on the large scale turbulent eddies as well. Also, provided that the column density may be obtained by $\Sigma \sim \rho_l l$, we get the scaling $t_{\rm life} \propto \Sigma$.

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REFERENCES

Armstrong, J. W., Rickett, B. J., & Spangler, S. R. 1995, ApJ, 443, 209
Ballesteros-Paredes, J., Vázquez-Semadeni, E., & Scalo, J. 1999, ApJ, 515, 286
Ballesteros-Paredes, J., Hartmann, L. W., Vázquez-Semadeni, E., Heitsch, F., & Zamora-Avilés, M. A. 2011, MNRAS, 411, 65
Burkhart, B., Falceta-Gonçalves, D., Kowal, G., & Lazarian, A. 2009, ApJ, 693, 250
Falceta-Gonçalves, D., de Gouveia Dal Pino, E. M., Gallagher, J. S., & Lazarian, A. 2010, ApJ, 708, L57
Falceta-Gonçalves, D., de Juli, M., & Jatenco-Pereira, V. 2003, ApJ, 597, 970
Falceta-Gonçalves, D., & Lazarian, A. 2011, ApJ, in press, arXiv:1104.2073
Falceta-Gonçalves, D., Lazarian, A., & Houde, M. 2010, ApJ, 713, 1376
Falceta-Gonçalves, D., Lazarian, A., & Kowal, G. 2008, ApJ, 679, 537
Galván-Madrid, R., Vázquez-Semadeni, E., Kim, J., & Ballesteros-Paredes, J. 2007, ApJ, 670, 480
Goldreich, P., & Sridhar, S. 1995 ApJ, 438, 763
Larson, R. B. 1981, MNRAS, 194, 809