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The connection between prestellar cores and filaments in the Aquila molecular cloud complex

Vera Könyves[1] **and Philippe André**[1]

[1]Laboratoire AIM, CEA/DSM-CNRS-Université Paris Diderot, IRFU/Service d'Astrophysique, CEA Saclay, 91191 Gif-sur-Yvette, France
emails: vera.konyves@cea.fr, philippe.andre@cea.fr

Abstract. One of the main scientific goals of the *Herschel* Gould Belt survey is to elucidate the physical mechanisms responsible for the formation and evolution of prestellar cores in molecular clouds. In the ∼11 deg^2 field of Aquila imaged with *Herschel*/PACS-SPIRE at 70–500 μm, we have identified a complete sample of 651 starless cores, 446 of them are gravitationally-bound candidate prestellar cores. Our *Herschel* observations also provide an unprecedented census of filaments in the Aquila cloud and suggest an intimate connection between these filaments and the formation process of prestellar cores. Indeed, a strong correlation is found between their spatial distributions. These *Herschel* findings support a filamentary paradigm for the early stages of star formation, where the cores result from the gravitational fragmentation of the densest filaments.

Keywords. stars: formation, ISM: clouds, ISM: structure, ISM: individual objects (Aquila Rift complex), submillimeter

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The *Herschel* Gould Belt survey (André *et al.*2010) observations in the Aquila cloud ($d \sim$ 260 pc) have provided an essentially complete census of prestellar cores and dense filaments†. The cores have been identified using *getsources* (Men'shchikov *et al.*2012), and the filaments have been traced and compared by several methods (see Könyves *et al.*2010, 2015).

Fig. 1 shows the filamentary structure of the Aquila cloud, traced by the curvelet transform component (Starck *et al.*2003) of the column density map. Given the typical filament width of $\sim$ 0.1 pc (e.g., Arzoumanian *et al.*2011), this curvelet map provides information on the mass per unit length along the filaments (André *et al.*2010). The white areas highlight regions where this stability parameter exceeds half the critical line mass $M_{\rm line,crit} = 2c_{\rm s}^2/G$ (Inutsuka & Miyama 1997) and the filaments are thus likely gravitationally supercritical (see Könyves *et al.*2015).

A high fraction (∼90%) of our prestellar cores are above a background column density corresponding to $A_{\rm V} \sim 7$, while a similar high portion (∼75%) of these cores lie within the densest filaments with supercritical mass per unit length. As seen in Fig. 1 a strong correlation is found between the spatial distribution of prestellar cores and the densest filaments above $A_{\rm V}^{bg} \sim 7$, or above an approximately corresponding line mass of $\sim 16\,M_\odot$/pc along the filaments (André *et al.*2014, Könyves *et al.*2015).

Comparing the statistics of cores and filaments with the number of young stellar objects found by *Spitzer* in the same complex (Dunham *et al.*2013, Allen et al., in prep.), we also infer a typical timescale of ∼1 Myr for the formation and evolution of both prestellar cores and filaments.

In summary, our *Herschel* results support a scenario in which the formation of solar-type stars occurs in two main steps (André *et al.*2014): 1) the dissipation of large-scale magnetohydrodynamic waves generates quasi-universal filaments in the cold ISM, 2) the densest filaments fragment into prestellar cores by gravitational instability.

References

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† Maps and catalogs derived from our *Herschel* data can be found at the *Herschel* Gould Belt Survey Archive, http://gouldbelt-herschel.cea.fr/archives.

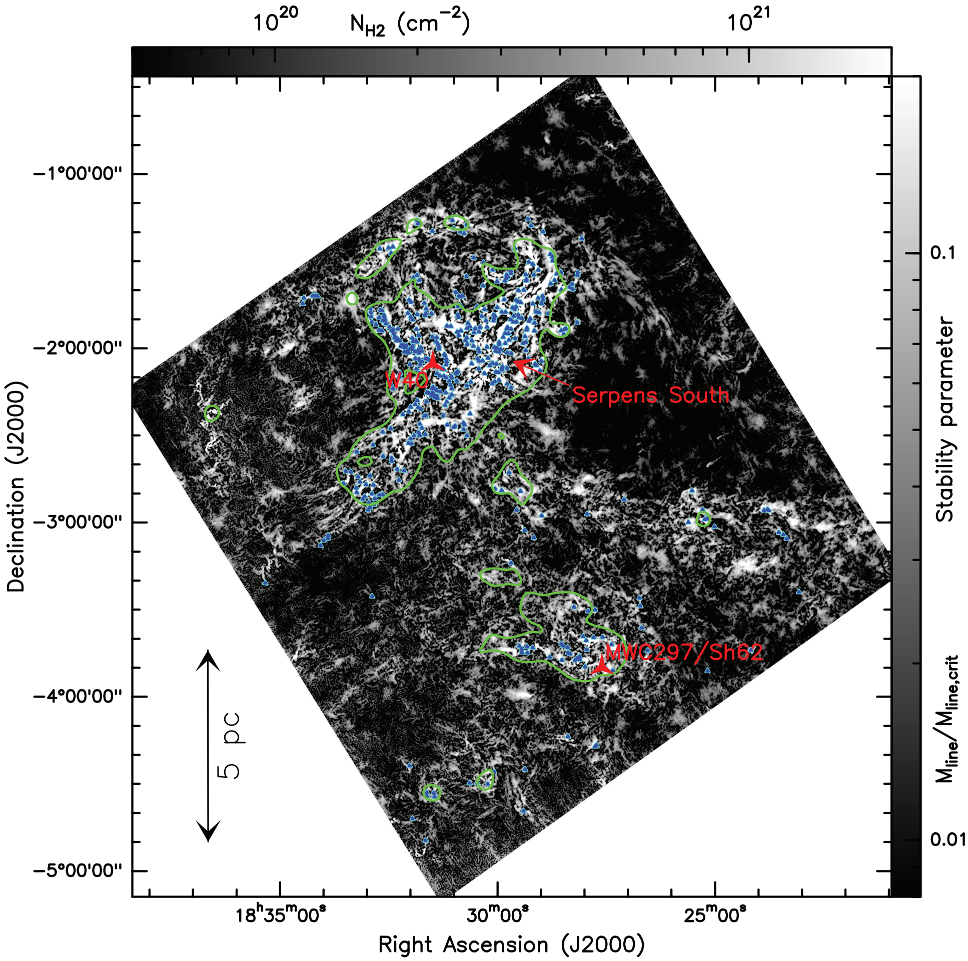

Figure 1. Spatial distribution of the prestellar cores (blue triangles) and the network of filaments in the Aquila cloud as traced by the curvelet component of the *Herschel* column density map. The likely gravitationally unstable filaments are highlighted in white, and the green contours correspond to $A_V \sim 7$ (Könyves *et al.*2015).

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