Origins: From the Protosun to the First Steps of Life
Proceedings IAU Symposium No. 345, 2018
B. G. Elmegreen, L. Viktor Tóth & M. Güdel, eds.

doi:10.1017/S1743921319002254

Pre- and protostellar cores in the Rosette Nebula

R. Bőgner[1], T. Csengeri[2], M. Wienen[3], N. Schneider[4], J. Montillaud[5] and L. V. Tóth[1,6]

[1]Department of Astronomy, Eötvös Loránd University,
1/A Pázmány Péter sétány, 1117 Budapest, Hungary
email: r.bogner@astro.elte.hu

[2]Max-Planck-Institut für Radioastronomie, 69 Auf dem Hügel, 53121 Bonn, Germany

[3]College of Engineering, Mathematics and Physical Sciences, University of Exeter, North Park Road, EX4 4QL Exeter, UK

[4]I. Physikalische Institut, University of Cologne, 77 Zuelpicher Str., 50937 Cologne, Germany

[5]Institut Utinam, CNRS UMR 6213, OSU THETA, Université de Franche-Comté, 41 bis avenue de l'Observatoire, 25000 Besançon, France

[6]Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences, 15-17 Konkoly-Thege Mikló út, 1121, Budapest, Hungary

Abstract. Recent theories on the formation of the Solar System turned the attention to the study of low mass cloud cores in massive star forming regions. The Rosette Molecular Cloud is a well-known star forming area having highly filamentary structure with dense cores covering a wide range of masses. These pre- and protostellar cores were observed by Herschel and key core properties were derived from its data. With the Effelsberg 100m telescope a sample of these cores with masses ranging between 3-40 $M_\odot$ were observed in ammonia inversion lines. In this work we are examining the correlations between these two datasets with the aim of gaining insight of the processes behind the star formation of the region.

Keywords. stars: formation, radio lines: ISM

1. Introduction

The earliest stages of high-mass star formation is an actively researched area. High-mass stars are rarer according to the initial mass function, they are found at larger distances than low-mass star forming regions and evolve on a much shorter timescale in complex and dynamic environments. They originate in clusters and since a large fraction of all stars form in such environments, the very first stages of high mass star formation can represent the initial condisitons for star formation in general (Sridharan *et al.* 2005). The density of high-mass star forming regions is around the critical NH_3 volume density ($\sim 10^4\,\mathrm{cm}^{-3}$), therefore NH_3 is suitable for investigating the parameters of high-mass star forming cores without the surrounding lower density structures.

The Rosette Nebula at a distance of 1.6 kpc is an emission nebula where the central OB cluster NGC 2244 is blowing a cavity into the surrounding molecular cloud (Schneider *et al.* 2010). The role of triggered star formation in this area is debated: Cambrésy *et al.* (2013) claimed that the evolution of the Rosette complex is not governed by the influence of its OB star population, and that simply the morphological appearance of an active region is not sufficient to conclude much about the triggering role.

With its wavelength coverage the Herschel satellite could detect massive young stellar objects at all evolutionary stages (Montillaud *et al.* 2015) and was able to detect the

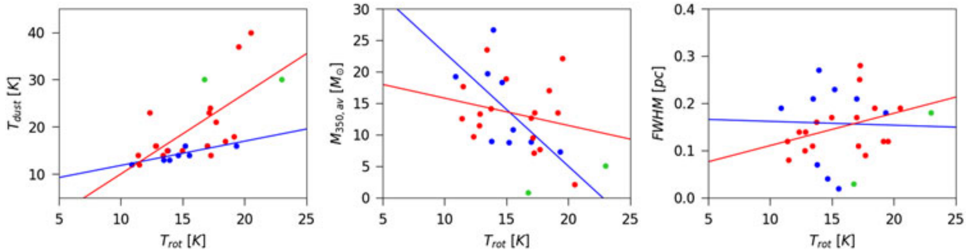

Figure 1. Correlation plots of rotational and dust temperature, mass and physical size of the cores, respectively. Green: warm-starless, blue: prestellar, red: protostellar cores. Weak correlation can be seen between the rotational and the dust temperatures by types.

precursors of O and B stars. Cores in early evolutionary phases of the Rosette Molecular Cloud were observed by Herschel and discussed by Motte *et al.* (2010) and Hennemann *et al.* (2010). The Effelsberg NH_3 observations make it possible to calculate properties of the molecular gas associated with the cores, complementing Herschel data.

2. Results and discussion

Single-point NH_3 observations were carried out in 2011 with the Effelsberg 100m telescope. 28 of the observed cores had detectable NH_3 (1,1) and (2,2) lines with an average rms level of 0.01 K. Data reduction was performed with the methods of Wienen *et al.* (2012). Rotational and kinetic temperatures, thermal linewidths and NH_3 column densities were calculated.

From Herschel data Motte *et al.* (2010) derived physical properties of the cores (dust temperature, mass, FWHM size) and classified them using Spitzer 24 m data into warm-starless, pre- and protostellar sources, our sample having 2, 9 and 17 sources, respectively.

Acknowledgements

This work is based on observations with the 100-m telescope of the MPIfR (Max-Planck-Institut für Radioastronomie) at Effelsberg. Herschel is an ESA space observatory with science instruments provided by European-led Principal Investigator consortia and with important participation from NASA. We thank the French ministry of foreign affairs (French embassy in Budapest) and the Hungarian national office for research and innovation (NKFIH) for financial support (Balaton program 40470VL/2017-2.2.5-TÉT-FR-2017-00027). This research is supported by the Hungarian OTKA grant NN111016. R.B. is grateful to the Physics Doctoral School of Eötvös Loránd University, Erasmus+, the French government, CampusFrance and the IAU for supporting her work. T.Cs. acknowledges support from the *Deutsche Forschungsgemeinschaft, DFG* via the SPP (priority programme) 1573 'Physics of the ISM'.

References

Sridharan, T. K., Beuther, H., Saito, M., Wyrowsky, F., & Schilke, P. 2005, *ApJ*, 634L, 57S
Motte, F., Zavagno, A., Bontemps, S., *et al.* 2010, *A&A*, 518, L77
Hennemann, F., Motte, F., Bontemps, S. *et al.* 2010, *A&A*, 518, L84
Schneider, N., Motte, F., Bontemps, S. *et al.* 2010, *A&A*, 518, L83
Wienen, M., Wyrowski, F., Schuller *et al.* 2012, *A&A*, 544, A146
Cambrésy, L., Marton, G., Fehér, O., Tóth, L. V., Schneider, N. 2013, *A&A*, 557, A29
Montillaud, J., Juvela, M., Rivera-Ingraham, A. *et al.* 2015, *A&A*, 584, A92

https://doi.org/10.1017/S1743921319002254 Published online by Cambridge University Press