Star formation history in the solar neighbourhood from the evolution of X-ray emission of young stars

Directeur de thèse : Laurent Cambrésy et Ada Nebot
Observatoire astronomique de Strasbourg, 11 rue de l'université, 67000 Strasbourg
Tel : 03 88 85 24 35 ; e-mail : laurent.cambresy@astro.unistra.fr
Tel : 03 88 85 24 20 ; e-mail : ada.nebot@astro.unistra.fr

The solar neighbourhood contains several giant molecular clouds, which are the sites of star formation (e.g. Orion, Taurus, Cygnus-X). Some of these clouds and their stellar population seem to form coherent structures whose exact shape, evolution and even existence are still debated. An obvious example is the Gould Belt (GB, [1]) for which a Radcliffe wave [2] is now being considered. Is it an expanding ring resulting from the explosion of a supernova several million years ago or a larger structure connecting two spiral arms but whose mode of formation is not understood?

Combining X-ray with optical observations can reveal large scale local structures such as the late type stellar component of the GB revealed by ROSAT-Hipparcos [3]. The X-ray emission of young stars depends on several intrinsic parameters of these objects. While for main sequence stars the stellar rotation decreases with age due to angular momentum losses in their stellar winds, the situation for young stars is still not clear. Most observational studies support that for very young stars magnetic star-disk coupling slows their rotation, but some studies seem to contradict this scenario ([4] and references therein). Additional studies covering a wide range of ages and masses are needed in order to learn about how accretion disks, magnetic fields and stellar winds affect angular moment losses. We propose to study young stellar population within 2 kpc from the Sun to learn about the evolution of X-ray luminosity with stellar rotation, age and stellar mass. This study will give an insight into the structure, formation and evolution of nearby stars within the Galaxy.

We will use eROSITA DR1 (September 2023), Gaia DR3, TESS and 2MASS catalogues. We will combine the information on these catalogues, photometry, distances, proper motions, light curves and spectra to learn about the underlying mechanisms driving the X-ray emission of these young stars. From GaiaDR3 proper motions, distances and colours we will select clusters members. Using TESS light-curves we will differentiate between single and binary stars and determine their stellar rotation and/or orbital periods [5]. Combining the Gaia distances, 2MASS derived extinction with eROSITA count rates we will be able to determine the X-ray luminosity [6]. We will derive reddening, ages, masses and effective temperatures by comparing observed colour-colour and HR diagrams and spectral energy distributions with those expected from different evolutionary models of stars and of accreting objects [6]. We will compare our derived Lx-rotation-age results with recent results obtained with Chandra [7] and with those predicted by evolutionary models [8].

The cross-identification of large and heterogeneous catalogues with different spatial resolutions and object densities is challenging. We will benefit from the Centre de Données astronomiques de Strasbourg (CDS) experience and tools.

[1] C. A. Perrot and I. A. Grenier, A&A 404, 519 (2003) – DOI: https://doi.org/10.1051/0004-6361:20030477
[2] J. Alves et al., Nature 578, 237 (2020) – DOI: https://doi.org/10.1038/s41586-019-1874-z
[3] Guillout et al. 1998, A&A 337, 113 (1998) 1998A&A...337..113G
[4] Serna et al., ApJ 923, 177 (2021) – DOI: https://doi.org/10.3847/1538-4357/ac300a
[5] Magaudda et al., A&A 661, A29 (2022) – DOI: https://doi.org/10.1051/0004-6361/202141617
[6] Nebot et al., A&A 553, A12 (2013) – DOI: https://doi.org/10.1051/0004-6361/201220308
[7] Konstantin et al. ApJ 935, 43 (2022) – DOI: https://doi.org/10.3847/1538-4357/ac7c69
[8] Johnstone, Bartel & Gudel, A&A 649, A96 (2021) – DOI: https://doi.org/10.1051/0004-6361/202038407