Mem. S.A.It. Vol. 88, 808

Memorie della

A Herschel survey of outbursting sources

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Abstract We present the current progress of our investigation of 12 FU Orionis (FUors) and EXor (from the prototype, EX Lup) objects. The observational spectroscopic and photometric data of mainly Herschel and Spitzer will be accompanied by hydrodynamical simulations and thermo-chemical modeling in a Swiss-Austrian collaboration, aiming to improve our understanding of episodic outbursts of low-mass young stars.

1. Introduction

Episodic accretion has been recognized to play a central role in the accretion history of young stars. FU Orionis objects display strong optical outbursts that last several decades. They undergo accretion outbursts during which the accretion rate rapidly increases from typically $10^{-7} M_{\odot} yr^{-1}$ to $10^{-4} M_{\odot} yr^{-1}$ and stays high over time scales of several decades to hundreds of years. The origin of such accretion outbursts remains unclear and could be due to viscous-thermal instabilities in the disc, thermal instabilities induced by density perturbations due to e.g. a massive planet in the disc, tidal effects from close companions, a combination of gravitational instability and the triggering of the magnetorotational instability, or again accretion of clumps in a gravitationally unstable disc.

2. YSO observations

We observed 12 FUors and EXors with Herschel, namely Haro 5a IRS, HH 354 IRS, HH381 IRS, Parsamian 21, PP 13 S, Re 50 N IRS, V346 Nor, V733 Cep, V883 Ori, EX Lup and V1647 Ori. For more information on the targets themselves, see Audard et al. (2014) and "Ices, silicates, and gas in FU Orionis objects" (Audard, M. et al. A. 2010). The data covers the whole SED in the observable bandwidth of Herschel, using photometry and spectroscopy of PACS and SPIRE. For most targets there are also high-resolution line observations using the HIFI instrument. The Herschel data are accompanied by additional observations at shorter wavelengths performed by Spitzer. In addition to that, we use archival data for further photometry information.

3. Outlook

We will further complete the adjustment (based on photometry) and reduction of the PACS and SPIRE data, for obtaining full SEDs of the targets (see Fig. 2) which will be improved by stitching together the different spectra after

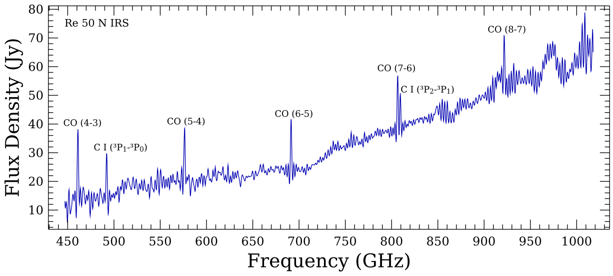

Figure 1. The unapodized SPIRE spectrum of the object Re 50 N IRS in the SLW channel (450-1050 GHz). Several CO emission lines were identified in the spectrum, as well as two C I transitions.

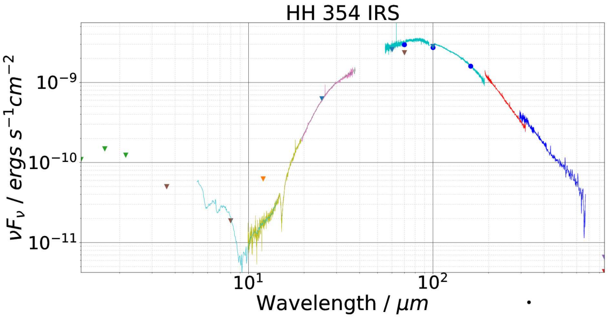

Figure 2. The SED of the object HH354 IRS including PACS spectra and photometry data (turquoise line + blue dots), SPIRE spectra (dark blue and red lines) combined with spectra from Spitzer (lines in other colors below 50 μm) and photometry from other sources.

matching them. There will be also an apodization of remaining spectra to get less noise in the continuum. When the data are in the final shape, there will be a detailed analysis of the spectra, focussing on lines of e.g. CO and H_2O (see Fig. 1) to extract environmental conditions. However, the main goal of this project is to perform a fit of the SED (dust continuum) and spectral lines (if available in the respective source) with the thermo-chemical simulation code ProDiMo (see Rab et al., 2017). The fit will be improved at a later time with a model of outbursting sources which is developed in our group in the mean time. Depending on the respective target, we are going to acquire information about the spatial distribution of molecules, as well as physical properties of the area. Our group is also performing hydrodynamical simulations (see Vorobyov & Basu, 2015) which will be used in the modelling procedure with ProDiMo. This will allow us to further constrain properties of the circumstellar disc and the surrounding envelope, e.g. its structure and mass.

Acknowledgements. We kindly thank the Swiss National Science Foundation (SNSF) (project number 200021L_163172) and the Austrian Science Fund (FWF) (project number I2549-N27) for their funding of this project.

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