The GENESIS project

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GENESIS (GENeration and Evolution of Structures in the ISm)

A German-french (ANR/DFG) collaborative project: https://www.astro.uni-koeln.de/GENESIS
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Objectives:

- Disentangle the relative importance of ***gravity, turbulence,*** and ***radiation*** during the molecular cloud- and star-formation process. Understanding how ***dense structures*** (filaments, cores,..) are forming.
- Identifying the spatial ***scales*** of turbulence dissipation, heating and cooling processes, the HI/H_2 transition.

Approach:

- Observations covering a large parameter space of density and excitation conditions from diffuse gas to giant molecular clouds, including filaments and dense cores. Assembling a large data set comprising ***FIR imaging of dust*** (*Herschel*) + ***THz spectroscopy*** of CII, high-J CO lines, OI,.. (SOFIA) + ***molecular lines*** + ***HI***
- Comparison to SPH and MHD ***simulations***, applying the same ***analysis tools*** (PDFs, $\triangle$-variance, WWCC,....).
- Apply novel, non-linear methods of signal analysis.

Workpackage gas cooling via far-infrared finestructure lines: S106

The bipolar nebula **S106** was mapped in FIR cooling lines (CII 158 µm, OI 63 µm, high-J CO lines) with GREAT on board **SOFIA**[a] (Schneider et al. 2018). Modelling the line emission with the KOSMA-tau code (Roellig et al. 2006) constrains a radiation field of a few times 10^4 and densities of a few times 10^4 cm^{-3}. We interprete the dark lane as an ***accretion flow*** and the binary system S106 IR being in a stage of its evolution where gas accretion is counteracted by the stellar winds and radiation, leading to the very complex observed spatial and kinematic emission distribution of the various tracers.

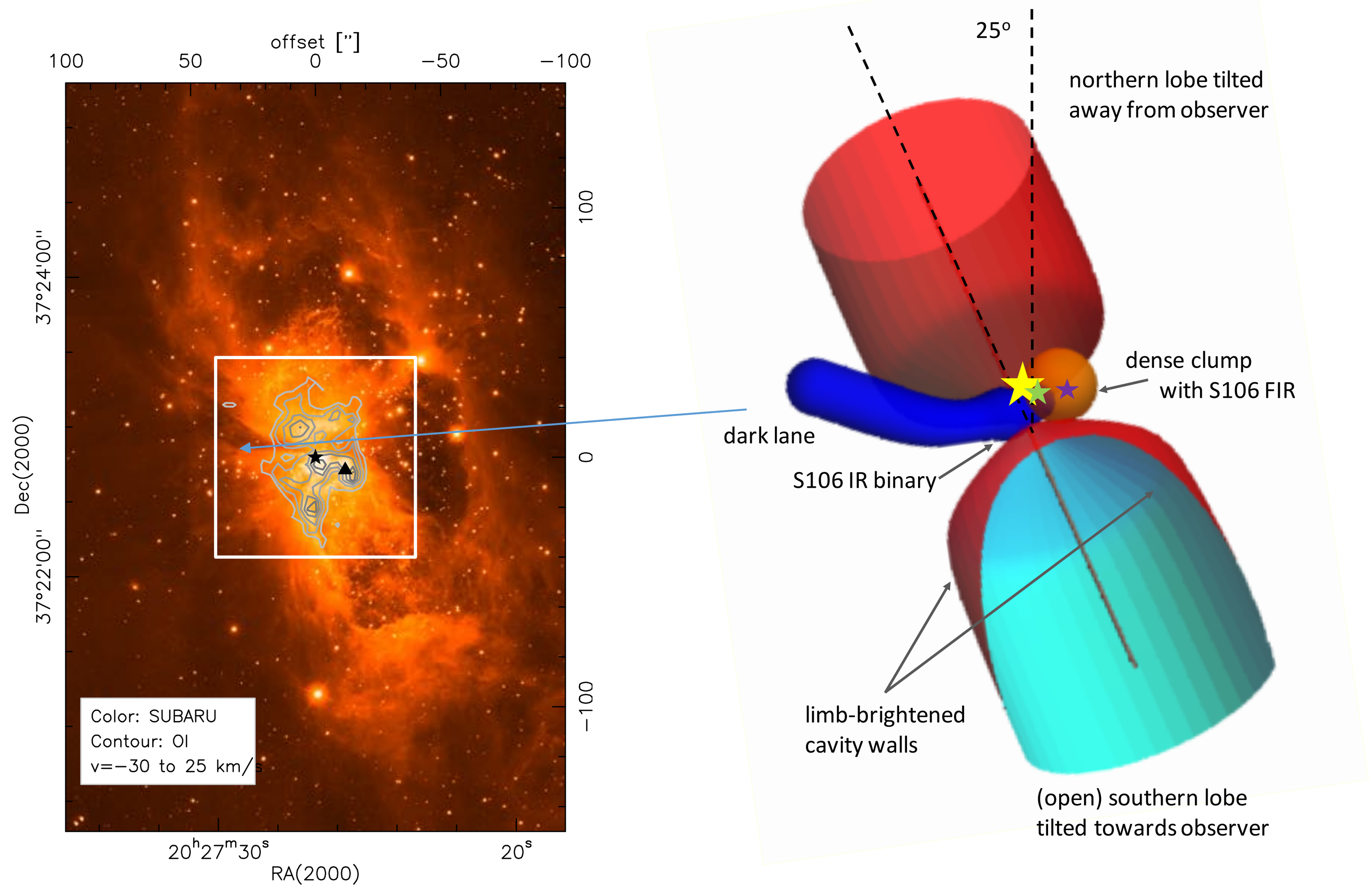

Fig.1: The S106 bipolar nebula in IR with line integrated OI emission overlaid, and a model of the region with the binary system S106 IR (Comeron et al. 2018) and the dark lane.

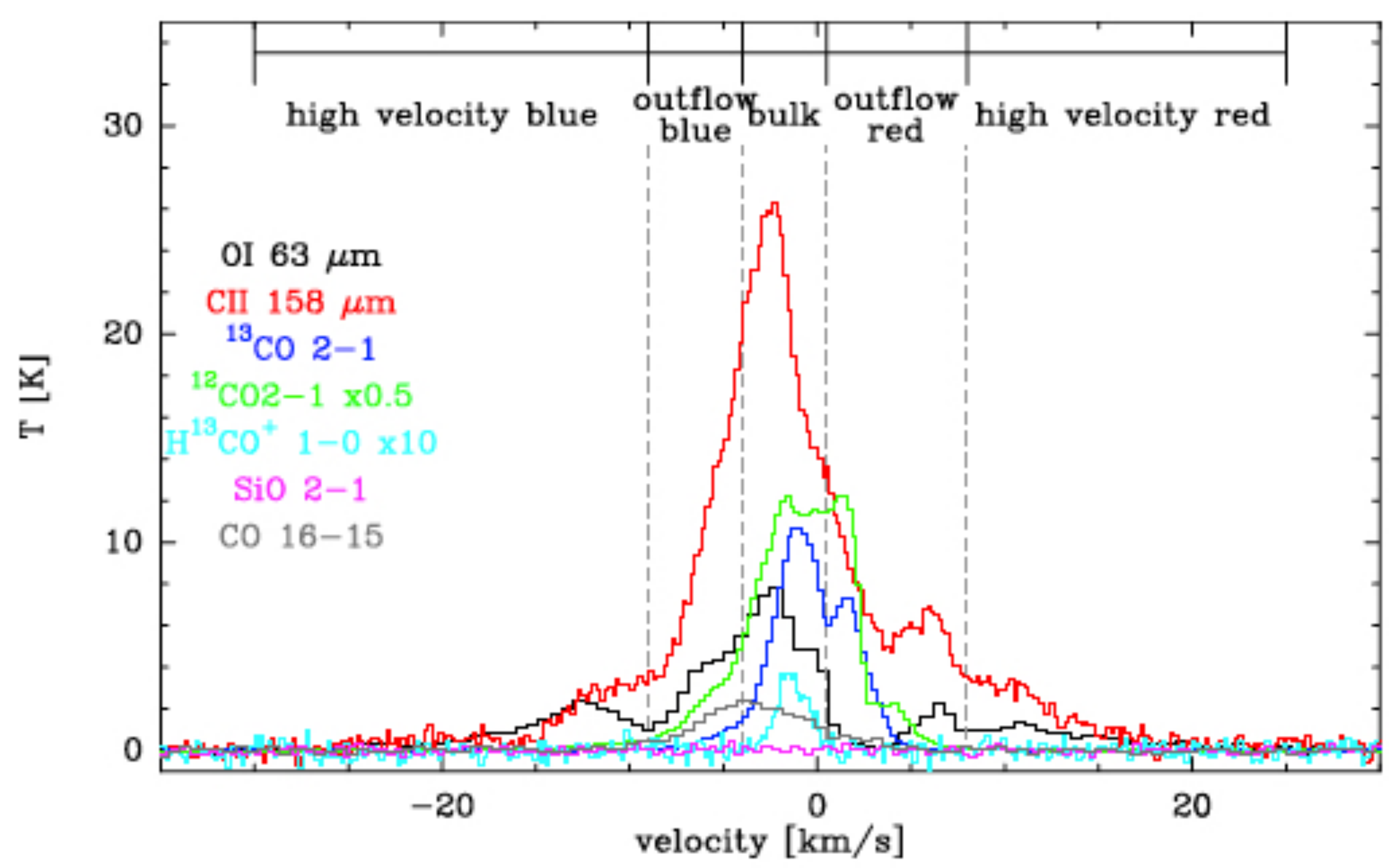

Fig.2: The OI and CII lines show high-velocity wings arising from highly excited PDR (photon dominated region) gas and/or shocks.

Workpackage molecular cloud formation: the HI/H_2 transition in Draco

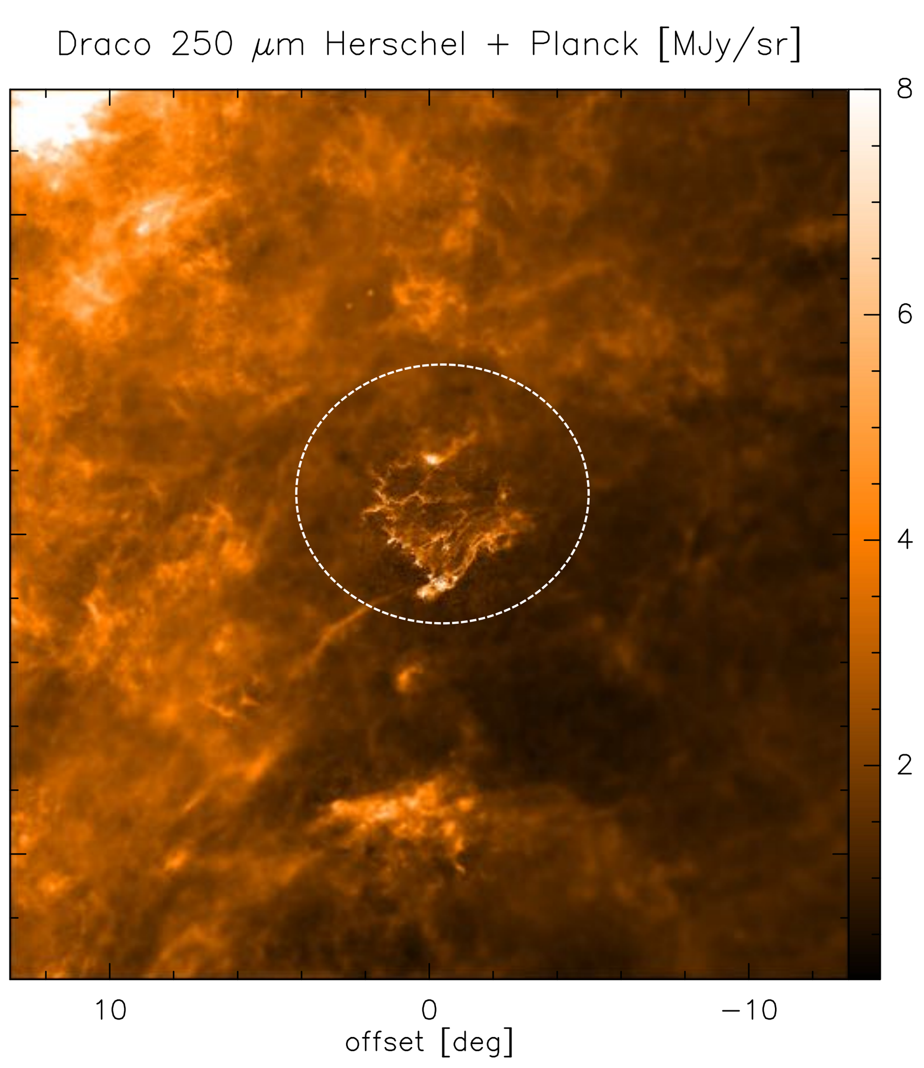

Fig.3: The Draco intermediate velocity cloud (center) at 250 µm (Schneider et al., in prep).

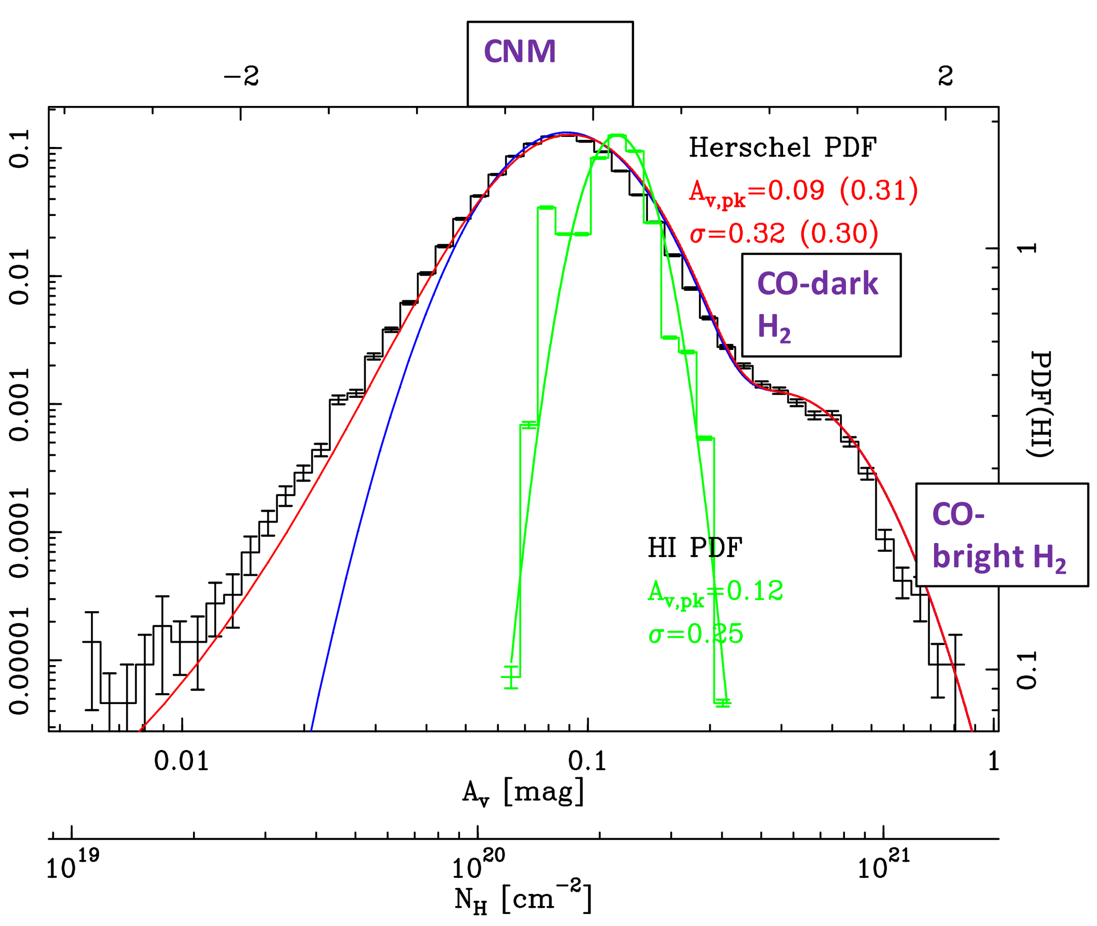

Fig.4: N-PDF of total dust column density (black) and atomic hydrogen (green), fitted by two lognormal and a noise tail (red),

The probability distribution function of total (H+H_2) gas (Fig. 4) in the **Draco** diffuse cloud (Fig. 3) shows a double-peaked shape that can be fitted by two lognormal PDFs and a noise tail. The peaks correspond to cold HI (CNM) and H_2, with a transition around Av=0.3 (Schneider et al. 2018, sub.)

We propose that Draco is an observational example for the **dynamic scenario for H_2 formation**: converging warm, turbulent HI flows lead to compression of HI gas that cools via thermal instability to form high density molecular gas.

[a]Stratospheric Observatory for Far-infrared astronomy

References: *Comeron F., et al., 2018, A&A in press;* Roellig M., et al., 2006, A&A 451, 917 ; Schneider N., et al., *2018, A&A in press*