The very early phases of star formation

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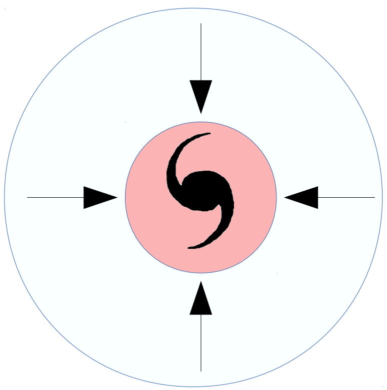
The t_0 in the life of a star

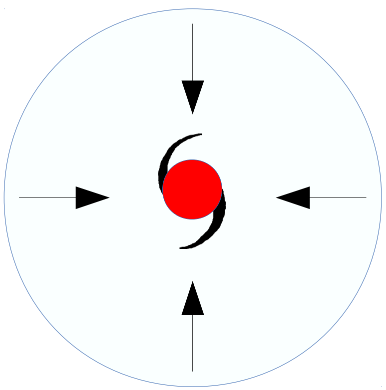
time



Prestellar core: gravitationally unstable, isothermal, mass collapsing to the centre
Envelope optically thin in the FIR, a source in the background could be seen through

As collapse proceeds the central regions become more dense but still optically thin

First Hydrostatic Core



Class 0 source:
star in the centre, larger and less massive than in the ZAMS, still accreting
Optically thick

The First Hydrostatic Core (FHSC)

1. represents the **first core** formed by the collapsing dusty envelope. Size is a few AU, mass typical of a giant planet (e.g., Omukai 2007)

2. marks the **transition between an optically thin**, isothermal core, **and an optically thick**, warm core, **in hydrostatic equilibrium**

3. important for star formation theory (e.g., fragmentation, final stellar mass)

4. **predicted by Larson (1969) 45 years ago but not firmly observed yet**

The First Hydrostatic Core (FHSC)

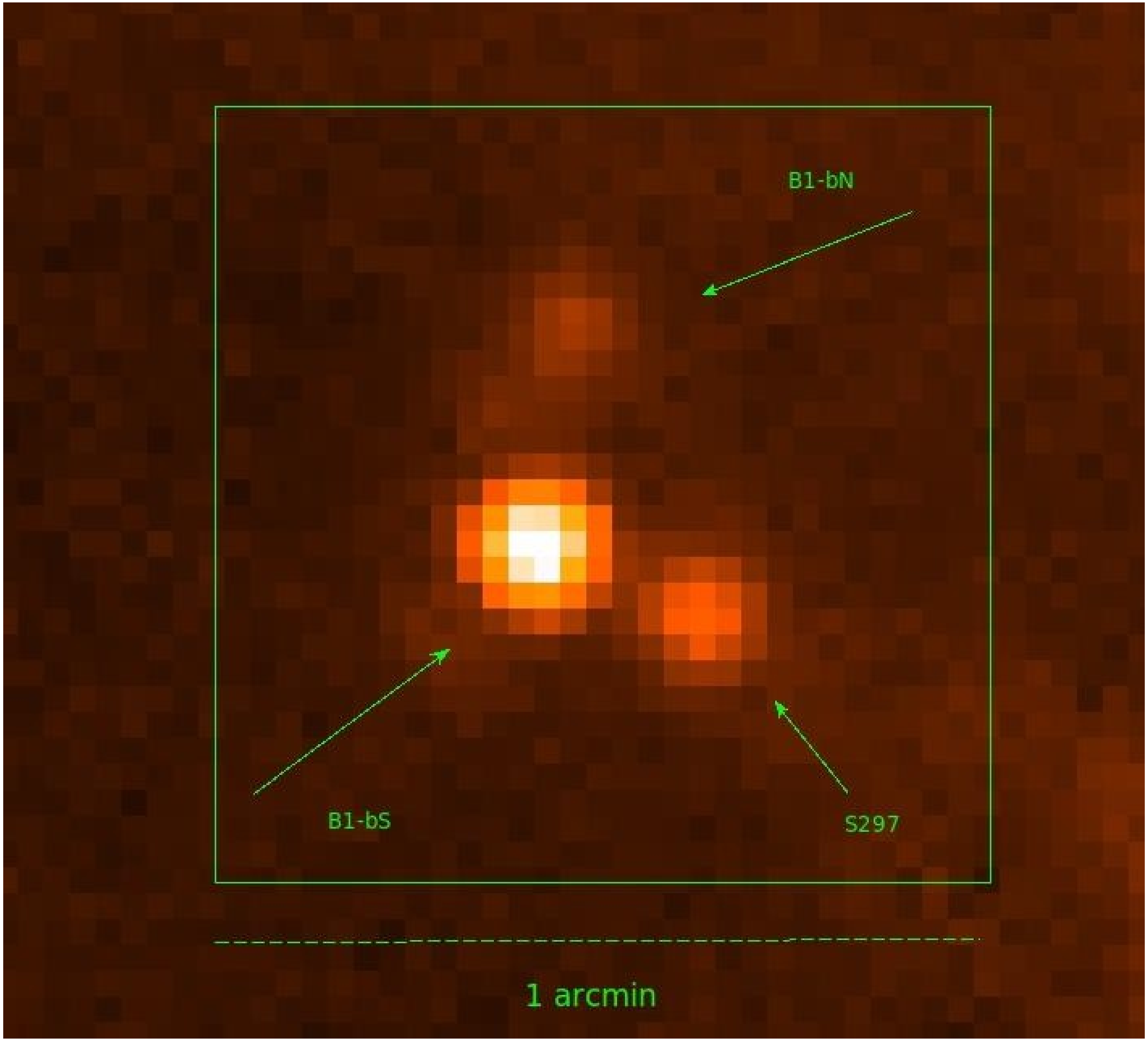
The FHSC phase is very short in time (few 10^2 – 10^3 years, e.g., Bate 2011) → **Very few objects expected to be found** while passing this phase

Currently less than 10 candidates (see Pezzuto et al. 2012 for a review)

Required:

- **SED between ~70 μm and ~100 μm** (Commerçon et al. 2012, below 70 μm not visible, above 100 μm SED of a prestellar core)
- **Spectral resolution of ~0.1 km/s** to derive the physical conditions → ALMA
- **High spatial resolution** to derive the radial intensity profile. ALMA is ideal in terms of resolution but at (sub)mm wavelengths

Perseus B1-bS and B1-bN



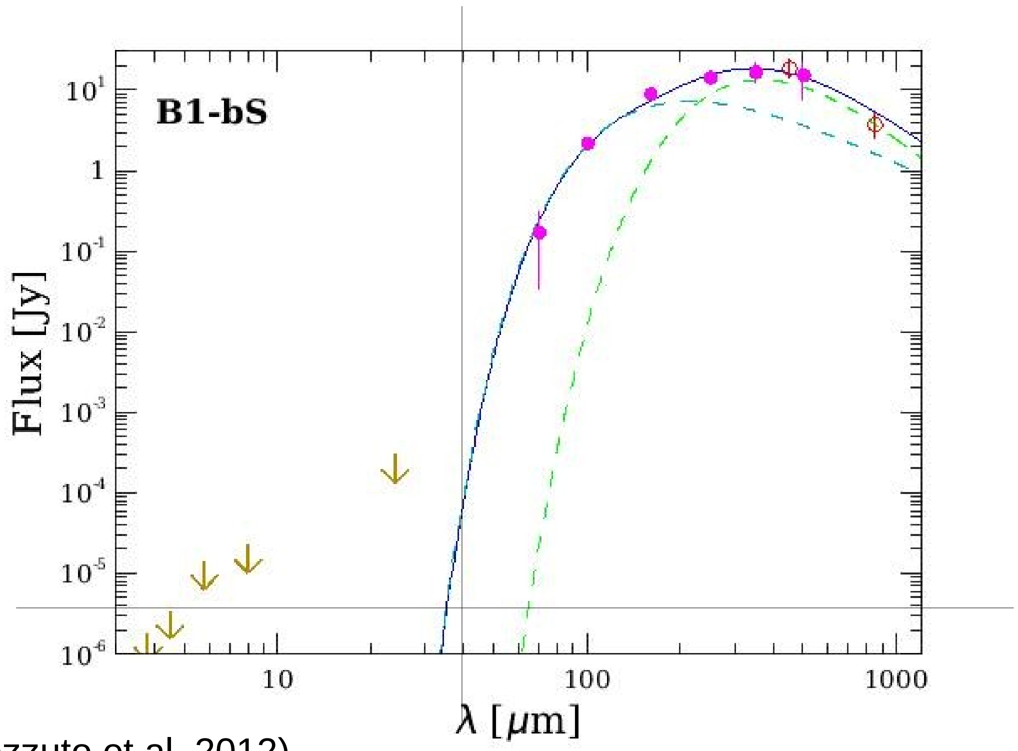
Herschel observed many near star-forming regions (Gould Belt Survey, André et al. 2010)

The star-forming region in Perseus was observed as part of this survey (Pezzuto et al., in preparation)

A first look at the data showed **a couple of sources whose SEDs are those expected from an FHSC** (Pezzuto et al. 2012)

A subsequent paper (Huang & Hirano 2013) added further, but not conclusive yet, evidence on their young status

The continuum

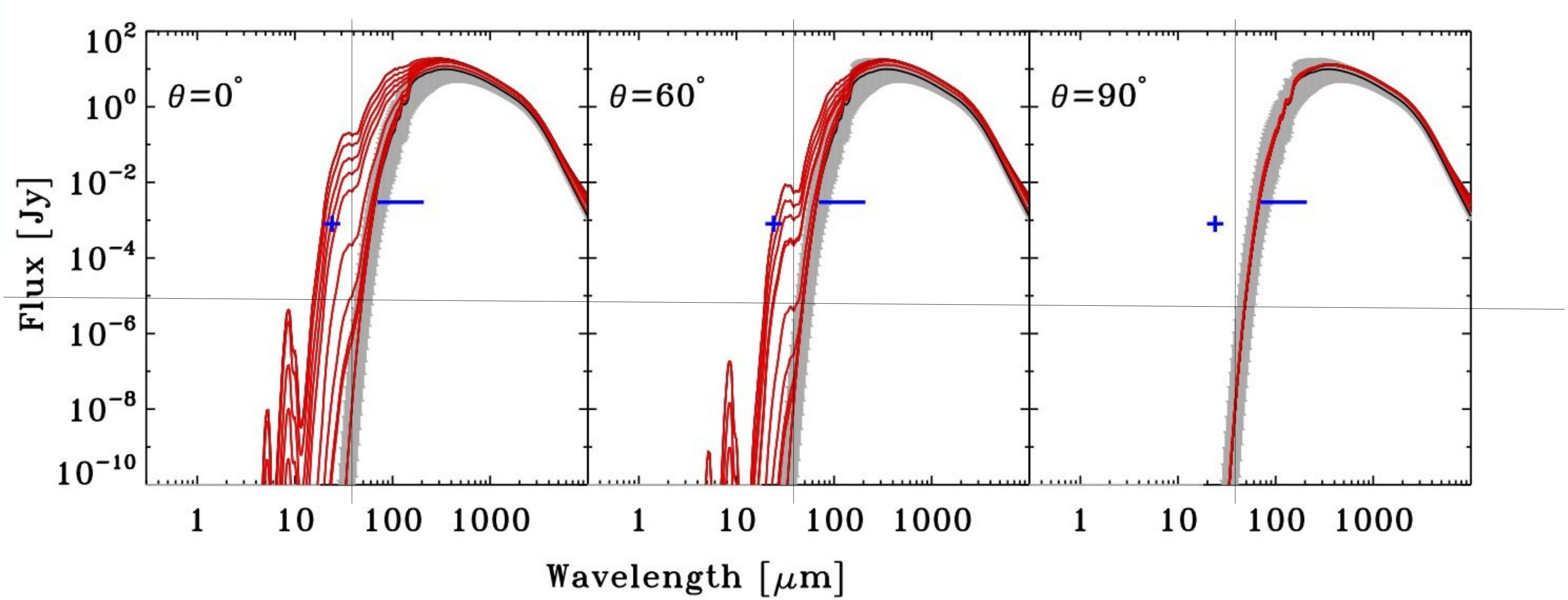


(Pezzuto et al. 2012)

Flux predicted at 40 µm: 70 µJy
FISICA sensitivity: 3.5 µJy (5σ, 24 hrs)

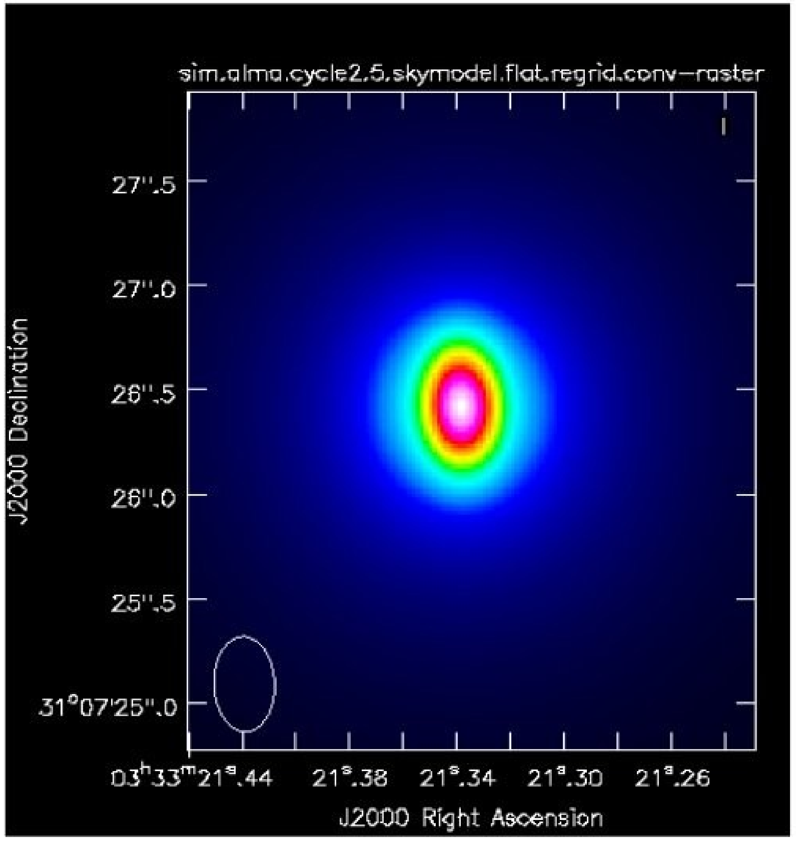
The flux is 20 times above the sensitivity limit

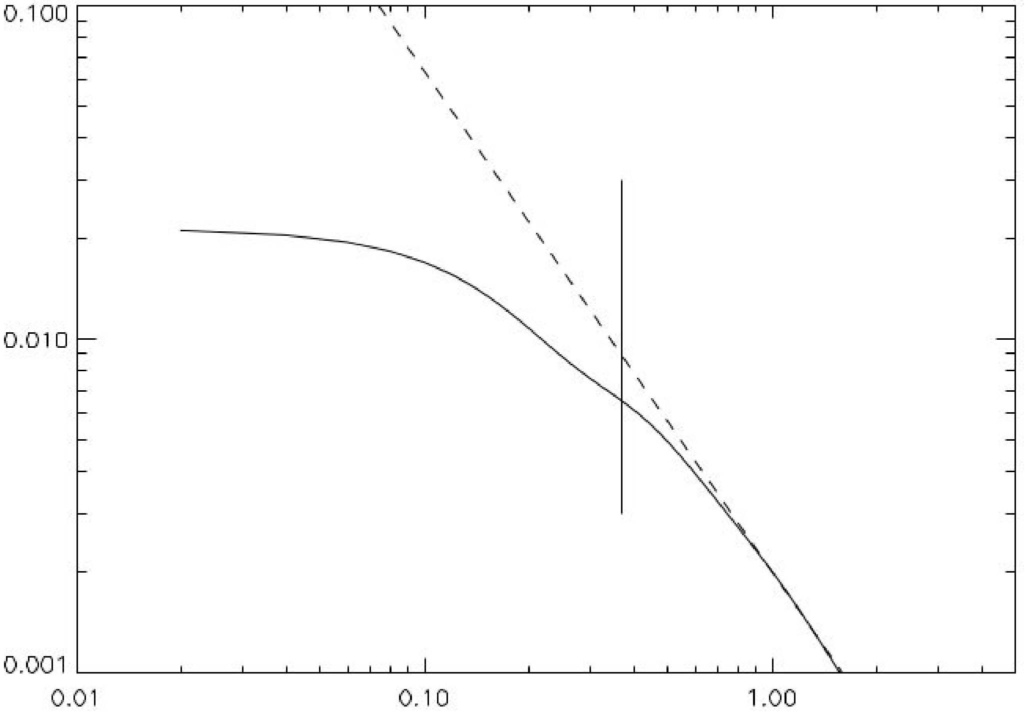
Theoretical SEDs



SEDs from Commerçon et al. (2012) for a FHSC at 150 pc. Shifting down the curves to the distance of Perseus (~250 pc) is equivalent to degrade the FISICA sensitivity by the same amount $(150/250)^2$ → 9.7 µJy @ 40 µm

The need of high spatial resolution





Simulation done with ALMA simulator at 850 µm

Sensitivity in H_2O line

Predicted brightness of H_2O lines (Omukai 2007): 5.44 10^{-20} W/m^2

Bright enough for FISICA: with a sensitivity of 3 10^{-20} W/m^2 (5σ, 24 hrs, range 140 – 280 µm) **less than 10 hours is enough for a 5σ detection**