

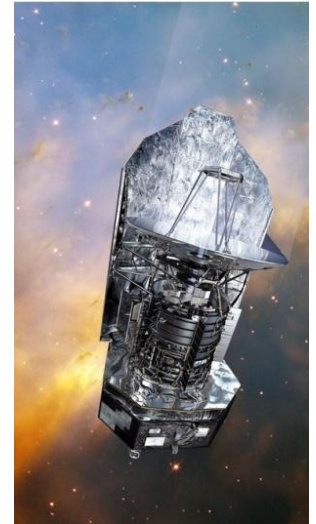
# Toward a full comprehension of the early phases of star formation with Herschel data

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# HERSCHEL SPACE OBSERVATORY

Three instruments for photometric (70 – 500  $\mu\text{m}$ )  
and spectroscopic observations (60- 670  $\mu\text{m}$ )



## THE ITALIAN CONTRIBUTION IN STAR FORMATION STUDIES (IAPS, OAR, OAA)

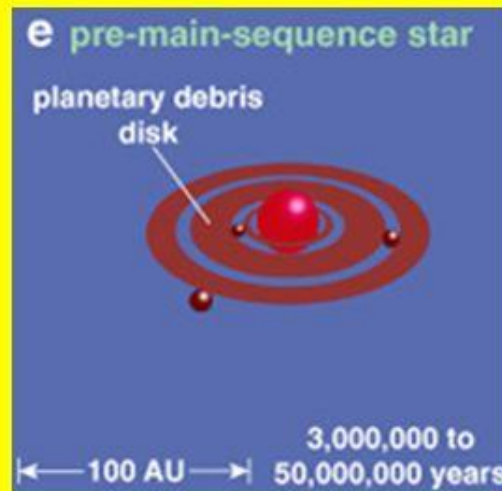
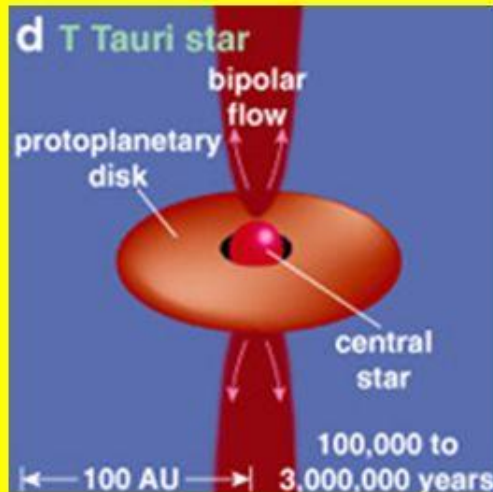
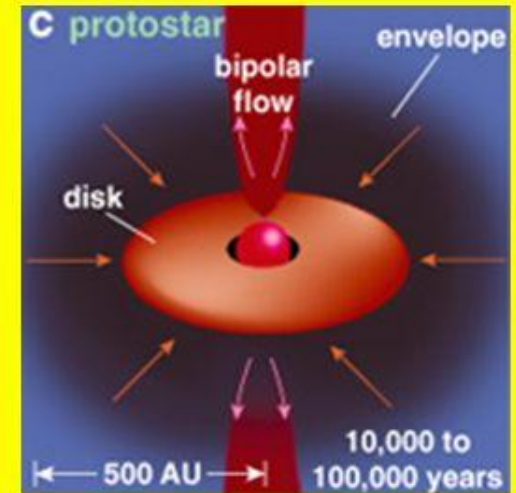
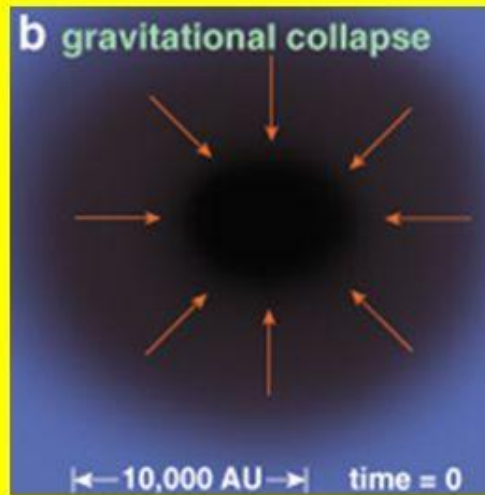
4 GT Key Projects (HGBS, HOBYS, WISH, CHESS)

1 OT Key Projects (Hi-Gal)

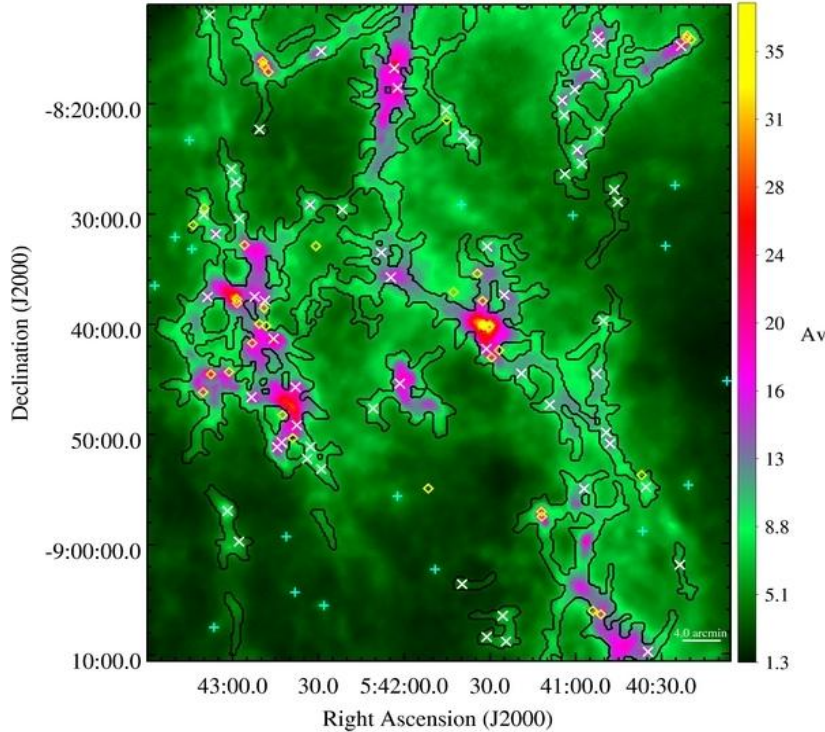
Several OT normal projects

# PRE - HERSCHEL VIEW

## Low Mass Star Formation ...

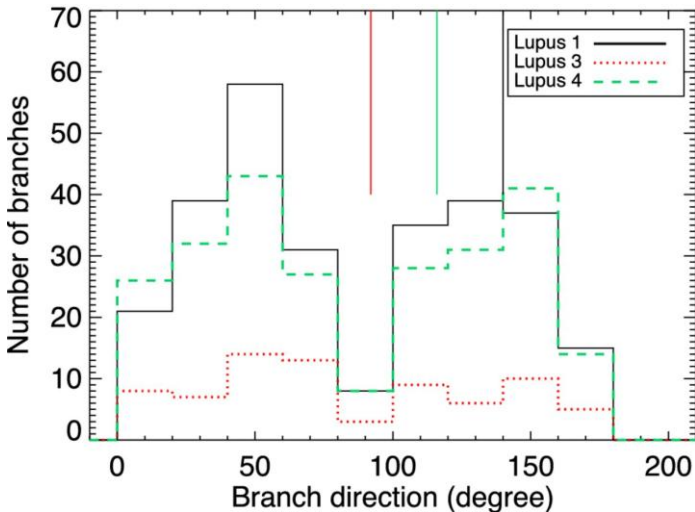


# HERSCHEL VIEW



The ISM in LMC is arranged in filamentary structures.  
Star are formed preferentially in filaments.  
About 80% of gravitationally bound pre-stellar cores are located on filaments

Polychroni et al. 2013

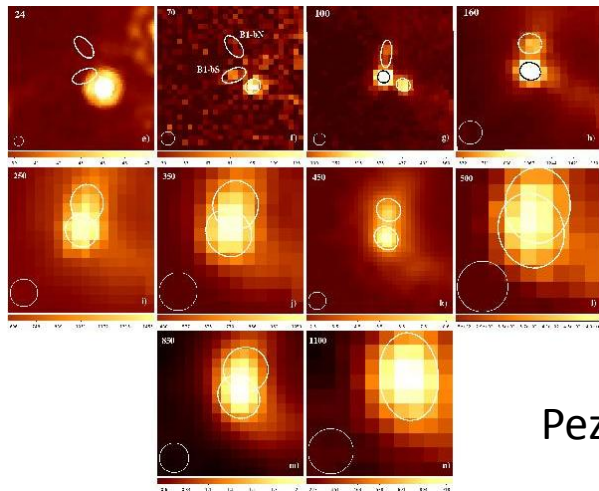


Filaments are mainly alligned along or orthogonally to the ambient magnetic field.

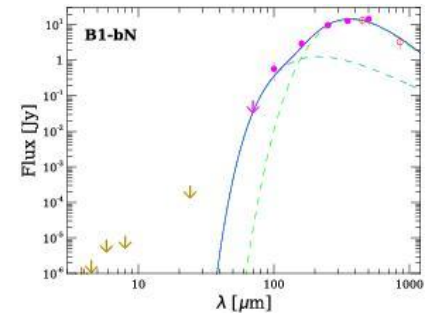
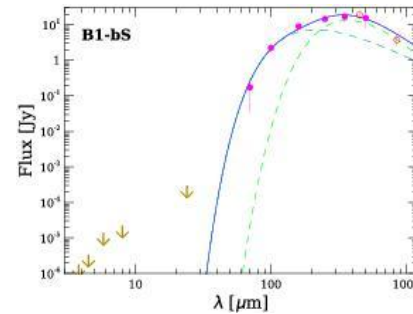
Benedettini et al. 2015

# HERSCHEL VIEW

Two candidate First Hydrostatic Cores.  
Images from 24 to 1100  $\mu\text{m}$

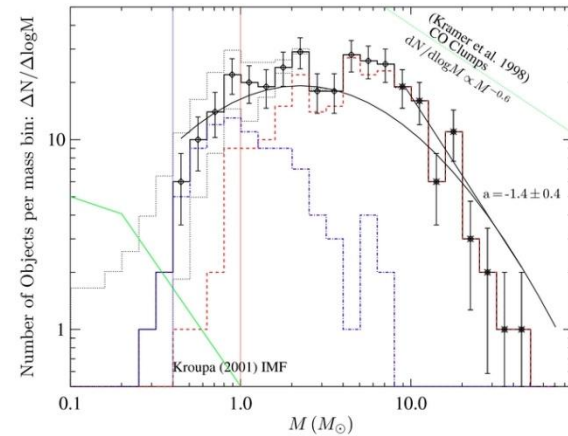


Pezzuto et al. 2012



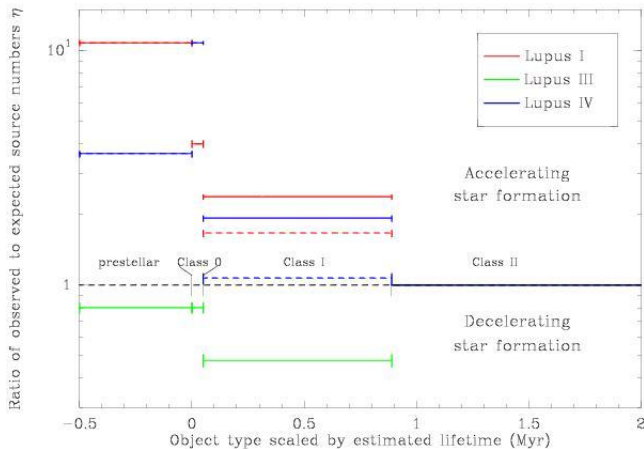
Substantial separation between the CMF of sources ON (red) and OFF (blue) filaments sources.

Polychroni et al. 2013

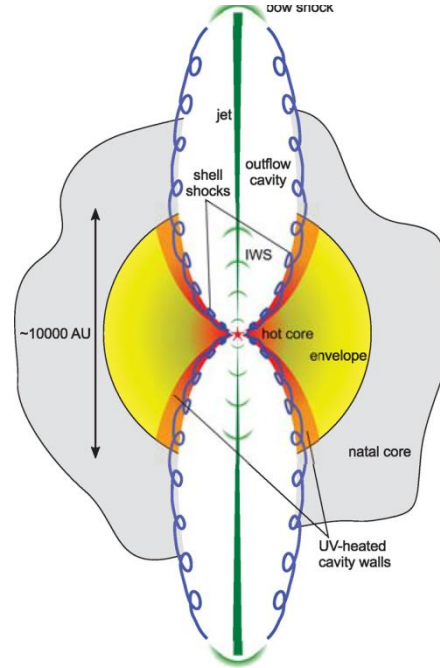
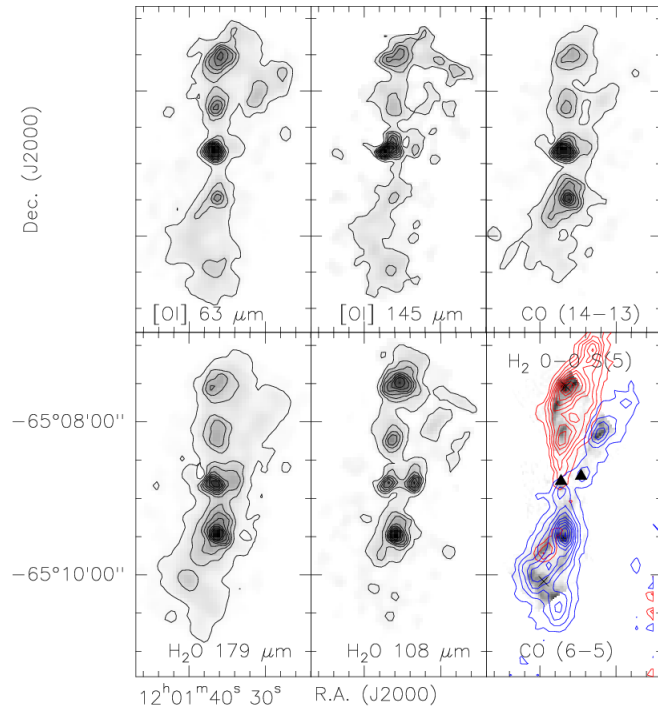


Different star formation history in the Lupus complex

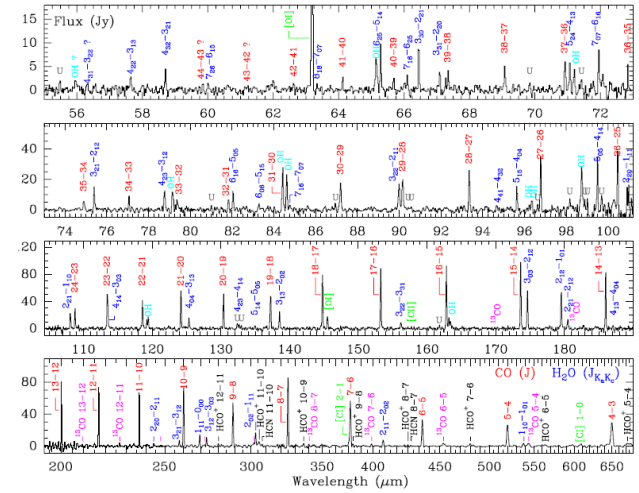
Rygl et al. 2013



# HERSCHEL VIEW



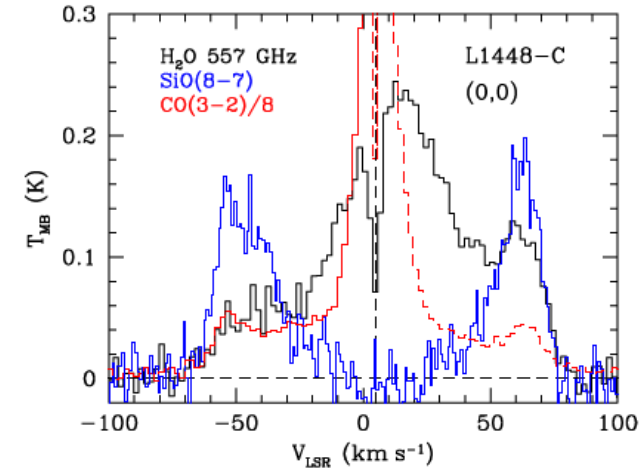
Van Dishoeck et al. 2011



Serpens SMM1 protostar  
 Goicoechea et al. 2012

BHR 71 outflow  
 Benedettini et al. in prep.

The complex protostar – outflow system.  
 Different contribution to the emission of  
 the warm gas



Nisini et al. 2013

# SOME OPEN QUESTIONS

## *FOR TODAY AND TOMORROW*

- How are filaments formed? How do they evolve? What is their role in the star formation process? What are the observed (morphological, physical and kinematical) properties of interstellar filaments?

*Filaments catalogues in low and high mass star forming regions; Large ground-based observing program: CO (1-0) survey @ ARO, “KEYSTONES” @ GBT; Proposals submitted to ALMA; FIRSPEX (proposal for ESA M5 call)*

- What is the CMF and how is it related to the SMF?

*Work in progress on: Lupus & Perseus (first draft ready by this Autumn); Serpens, Orion A, Vela C, W3 and W48 (to follow next year). Complement FIR Herschel data with NIR-MID JWST data*

# SOME OPEN QUESTIONS

## *FOR TODAY AND TOMORROW*

- How can further disentangle the contribution from envelope and shock around protostars? What are the major cooling channels of each component?
- How much is the feedback to the ISM from outflows and jets?

*Fundamental questions not addressable from ground. Further exploitation of Herschel data. Projects with JWST. Need for FIR space telescopes (e.g. SPICA, FIRSPEX, FLARE proposals for ESA M5 call)*