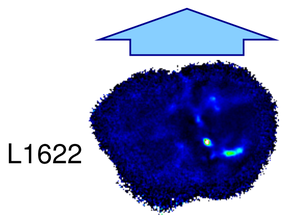
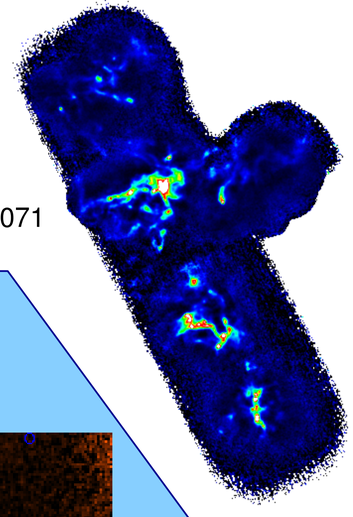
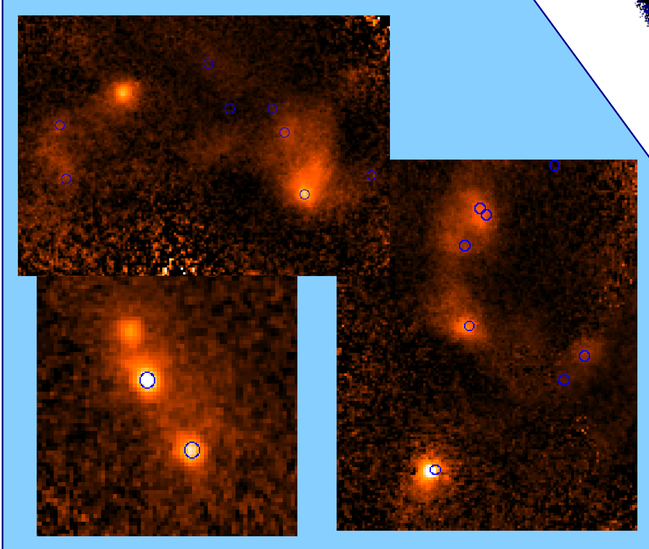
Mapping dust in Orion protostars: from Herschel to APEX

Thomas Stanke (ESO), Amy Stutz (MPIA Heidelberg), Tom Megeath (U. Toledo), & the HOPS team

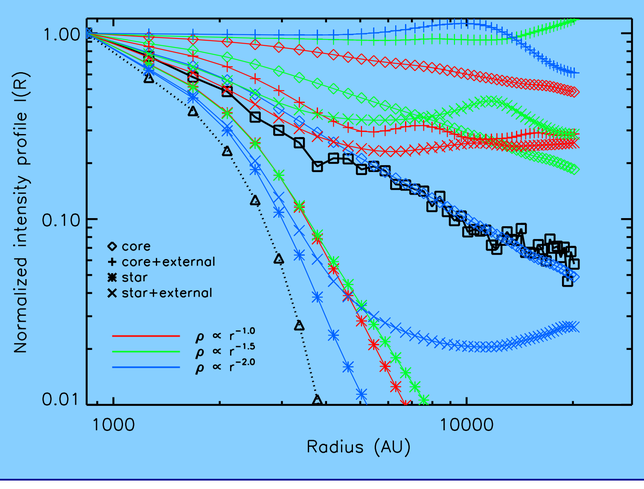
HERSCHEL ORION PROTOSTAR SURVEY

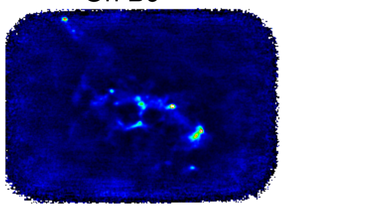


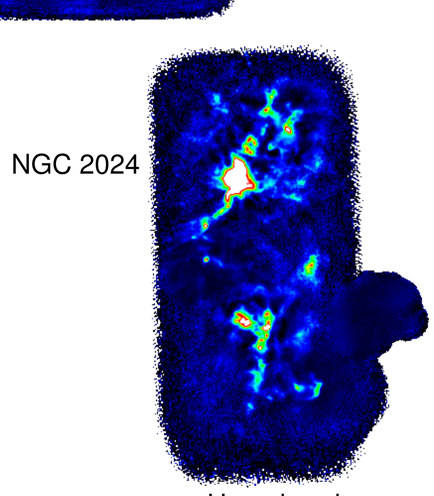


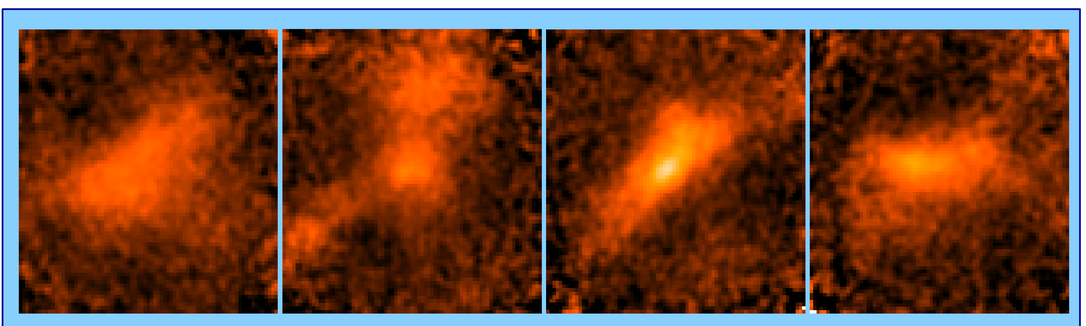


Saboca 350mum spatially resolves many (bright) envelopes –> constrain density and temperature profiles –> envelope masses



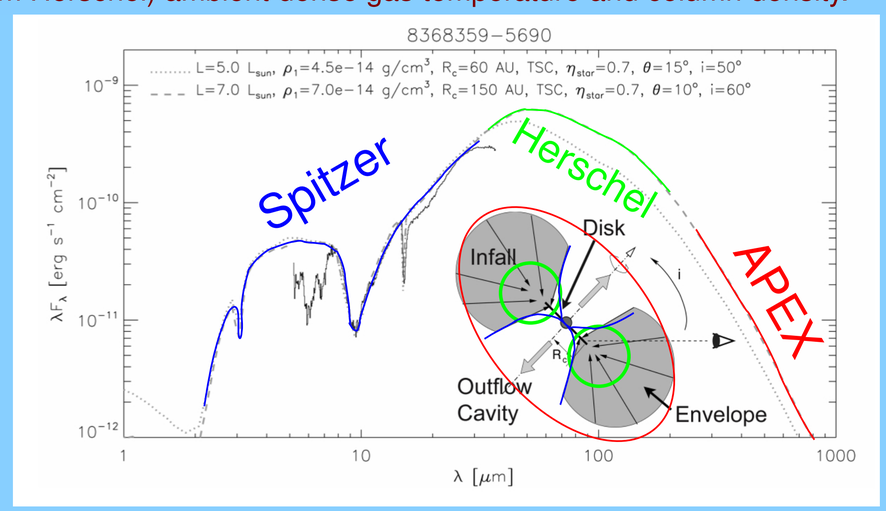






Summary:

- **HOPS (H**erschel **O**rion **P**rotostar **S**urvey): 200 h Herschel open time key project to obtain 70 and 160μm photometry of 370 protostar candidates in Orion A and B.
- Ancillary observations (ground and space based) at IR to mm wavelengths → SED, spatially resolved images.
- APEX Laboca (870μm, 19″/∼8000 AU beam) and Saboca (350μm, 7.″6/∼3000 AU beam) → constrain envelope mass and size + (with use of 160μm Herschel) ambient dense gas temperature and column density.

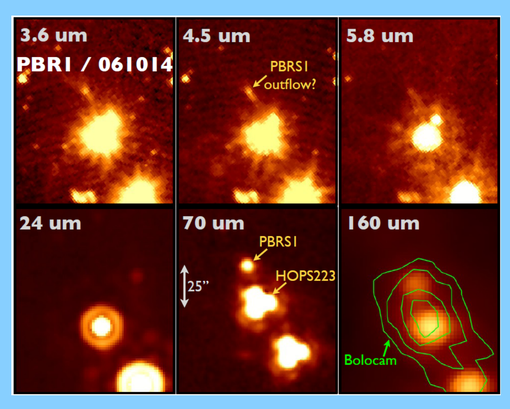


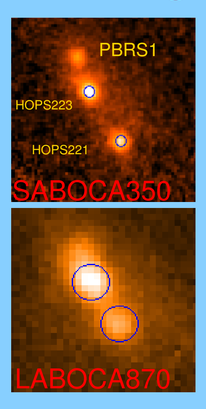
Spitzer, NIR: inner envelope/outflow cavity; geometry!

Herschel: warm inner envelope; luminosity!

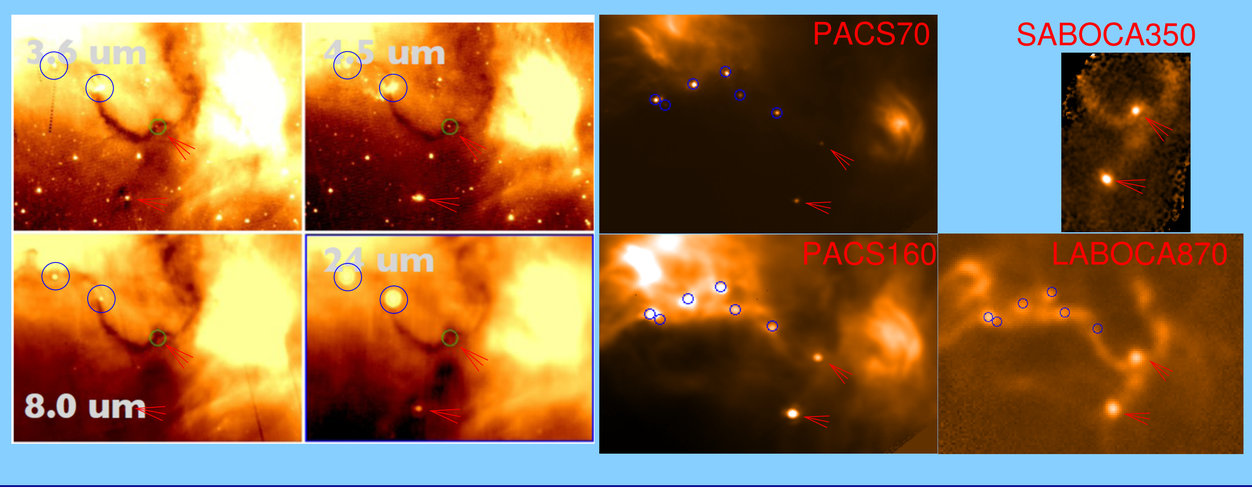
APEX: optically thin, total envelope mass and size

PBRS: PACS Bright Red Sources

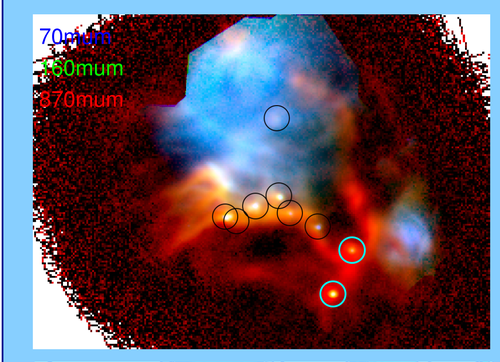




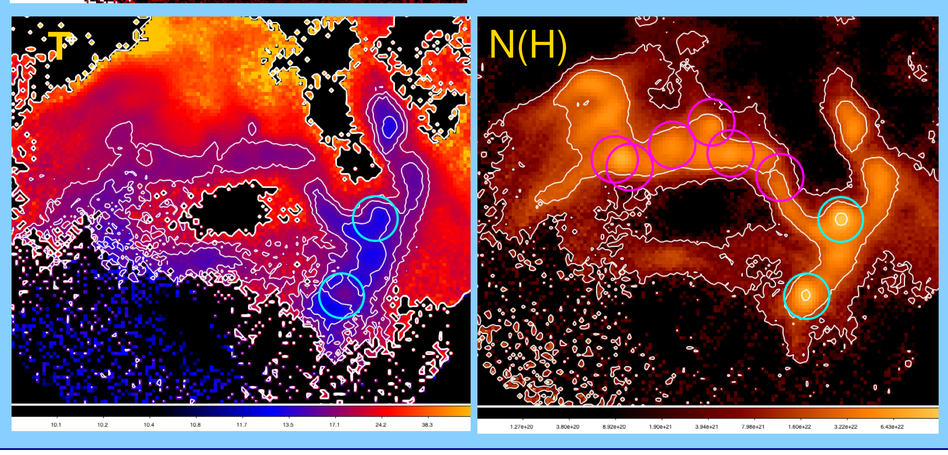
- Population of extremely red sources: not seen (or very faint) with Spitzer, bright in Herschel PACS images and submm maps (Stutz et al. 2013, ApJ 767, 36)
- extremely young Class 0 sources? (generally no strong outflow activity visible)
- edge on “normal” Class 0 sources?



(Preliminary!) dust temperature maps



- Herschel 160μm + Laboca 870μm → Dust temperature + column density
- Left: Herschel/Laboca color composite of NGC2068
- Below: PRELIMINARY dust temperature (left) and column density (right) maps in NGC 2068
- Some protostars (including PBRs) noticeably heat surrounding dust, many don’t.



Protostar spacing vs. column density

- Maps below: Laboca 870μm, same brightness scaling, same angular scaling
- Herschel 160μm + Laboca 870μm → column density →
- Spacing between protostars scales with column density of ambient gas
- Relation between column density and protostar spacing is consistent with Jeans fragmentation