The Herschel first look at protostars

Gould Belt and HOBYS key programmes

On the behalf of the SPIRE SAG3 consortium

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special thanks to
Ph. André, A. Men’shchikov, M. Hennemann, V. Könyves, N. Schneider, D. Arzoumanian, F. Motte
The (long) quest for protostars

- The Class I, I and III YSOs after IRAS (80’s)
- The Class 0 and pre-stellar cores after MM range surveys (90’s)
- Much more complete surveys with ISO and Spitzer (00’s)
- What about Herschel? … let’s try to guess a little … (10’s)

Objectives

- Probe the earliest stages of star formation.
- Timescale for proto-stellar evolution.
- Initial conditions for planet/disk formation.
- Discriminate between accretion histories.
The power of Herschel

- Full coverage of the peak of the SEDs.
- Spatial resolution in the FIR.
- Sensitivity: down to sub-stellar range.
- Both pre-stellar and protostars at the same time.
- Unprecedented statistics … up to high-mass stars in HOBYS.
The Aquila Rift / Serpens region

as part of the Gould Belt key programme (André et al.)
Talk on Monday and André et al. (2010)

2MASS extinction map - Bontemps et al.

Target list - Gould Belt survey
- 200' x 200' scan map in parallel mode at 60''/sec.
- A nearby complex at 260 pc; $3.1 \times 10^4 \, M_\odot$

Details in Kőnyves and André talks
Aquila Rift - W40/Sh2-64

Gould Belt key programme

PACS+SPIRE 160, 250, 350 µm
How to recognize protostars?

- Systematic getsources extraction (Men’shchikov et al. 2010; Könyves’s talk).
- + 24 or 70 µm point-like.
- Graybody fits of the SEDs.
- Physical sizes ~ 4000 AU (radius).
- Individual protostars resolved out.

Fundamental properties:
- Luminosities.
- Envelope masses.
First attempt for an evolutionary diagram

- In the whole Aquila region 201 protostars; 90% completeness at 0.2 $L_\odot$
- An evolutionary diagram with $L_{70-500\mu m}$ for the whole sample.
- $L_{>350\mu m}/L_{70-500\mu m} > 3\%$ (green dots); $L_{>350\mu m}/L_{70-500\mu m} < 1\%$ (red dots).
- to discriminate Class 0 from Class I YSOs (see André et al. 2000).

Bontemps et al. (2010)
A&A special issue
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\[ M_\ast < M_{\text{env}} \]

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Class 0

Class I

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\[ \text{Constant } M_{\text{acc}} \text{ Decreasing } M_{\text{acc}} \]
The Rosette Molecular Cloud:
- 60' x 80' scan map in parallel mode at 20''/sec.
- More distant cloud at 1600 pc; 3.5 x 10^5 M☉ as part of HOBYS (Motte et al.)
Talk on Friday and Motte et al. (2010)

Higher mass protostars in HOBYS
Individual Protostars In Rosette (1.6 kpc)

Spitzer
24 µm

70 µm

0.5 pc

Rosette Molecular Cloud - HOBYS - Hennemann et al. (2010)
Individual Protostars In Rosette (1.6 kpc)

Spitzer 24 μm
Herschel 70 μm

Rosette Molecular Cloud - HOBYS - Hennemann et al. (2010)
Herschel-only protostars

Rosette HOBYS - Hennemann et al. (2010)
Statistics towards high-mass stars in HOBYS
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Hennemann et al. (2010) and see his poster.
Unresolved protostars for $\lambda > 160 \, \mu m$
Conclusions

- A large number of protostars.
- Individual protostars in nearby regions.
- Between 45 and 60 Class 0s in Aquila
- Hundreds expected in the whole survey.

- Herschel-only protostars discovered.
- Huge statistics to constrain models.
- Decreasing accretion rate?
- ~50 Class 0s, 200 protostars, 550 PSCs…

… many thanks to the
Herschel teams for the wonderful telescope
the SPIRE and PACS technical teams for two great instruments.