Star Formation in CG1

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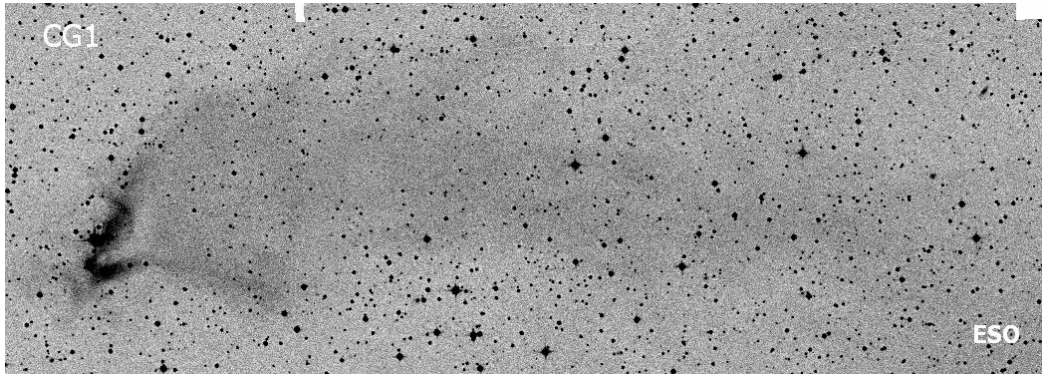
Paper I: Haikala, Mäkelä, Väisänen, 2010, A&A, 522: 106

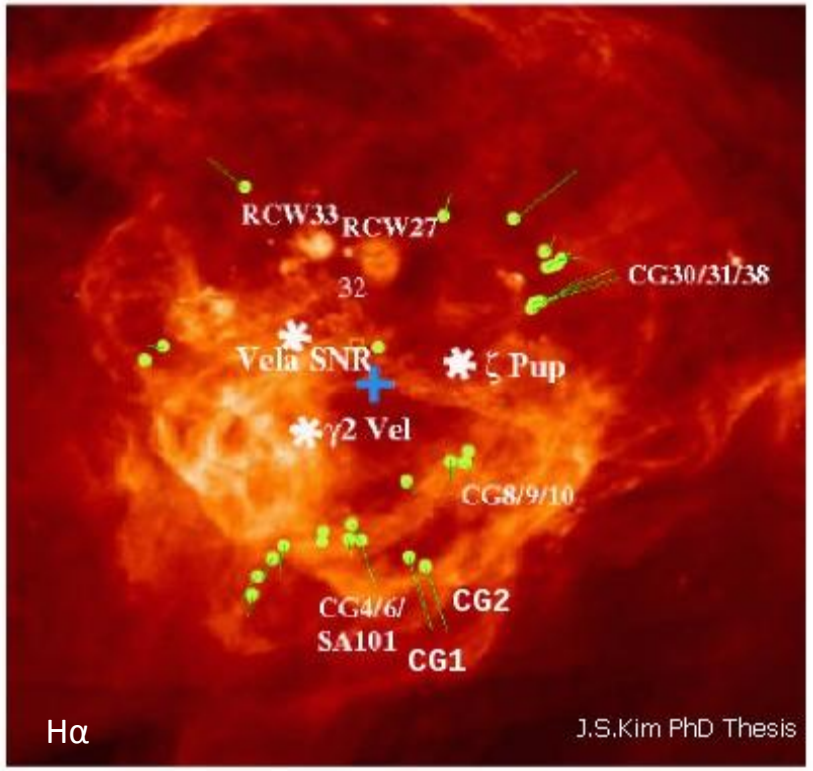
Outline

1. Introduction to cometary globules (CGs)
2. Results from near infrared (NIR) observations
3. Additional archive images
4. Summary

CGs in the Gum Nebula

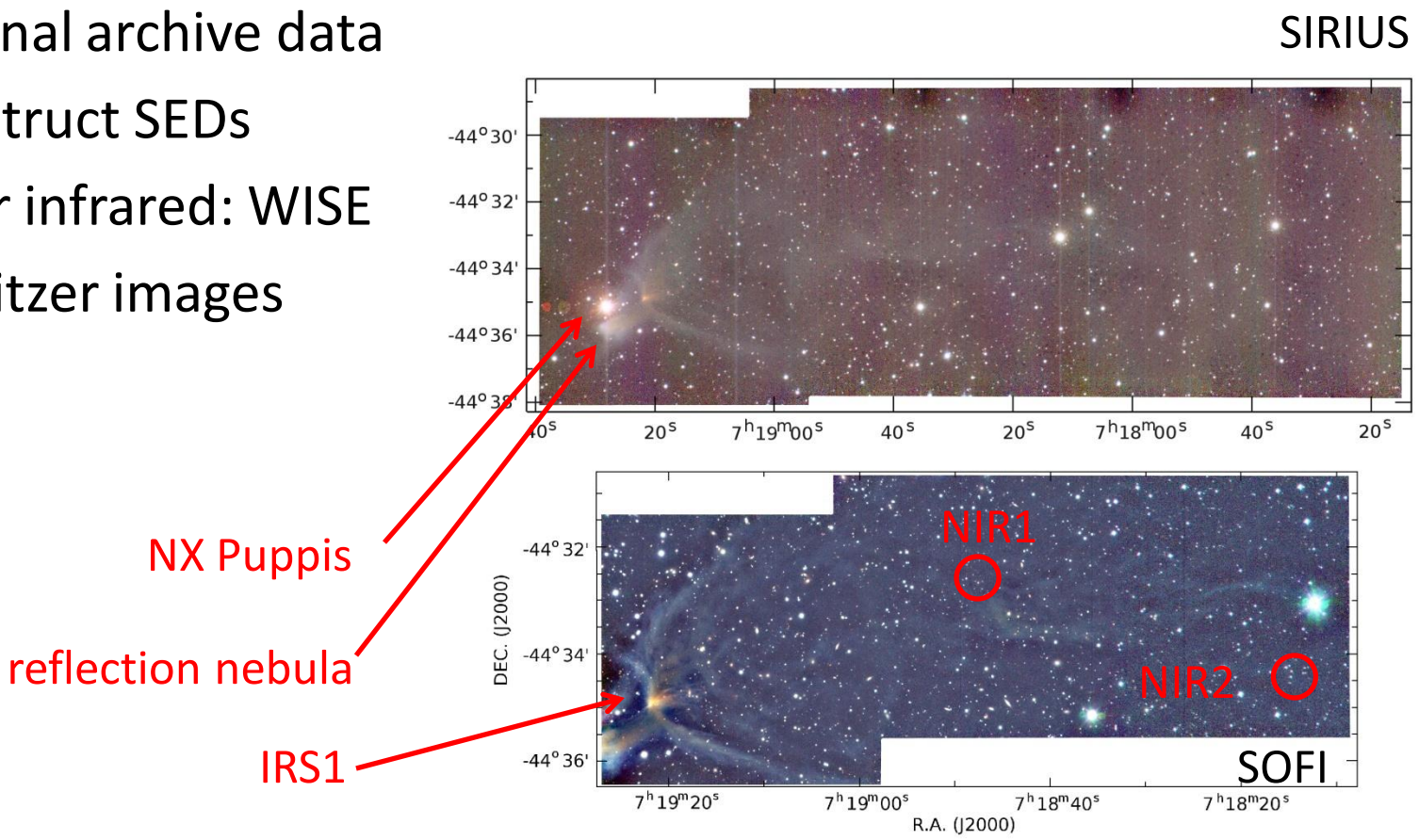
- Gum Nebula: a HII region and/or supernova remnant, d~36°
- O and B stars in the center
- distance 300-500pc
- CGs: dusty, compact heads and elongated, faintly luminous tails





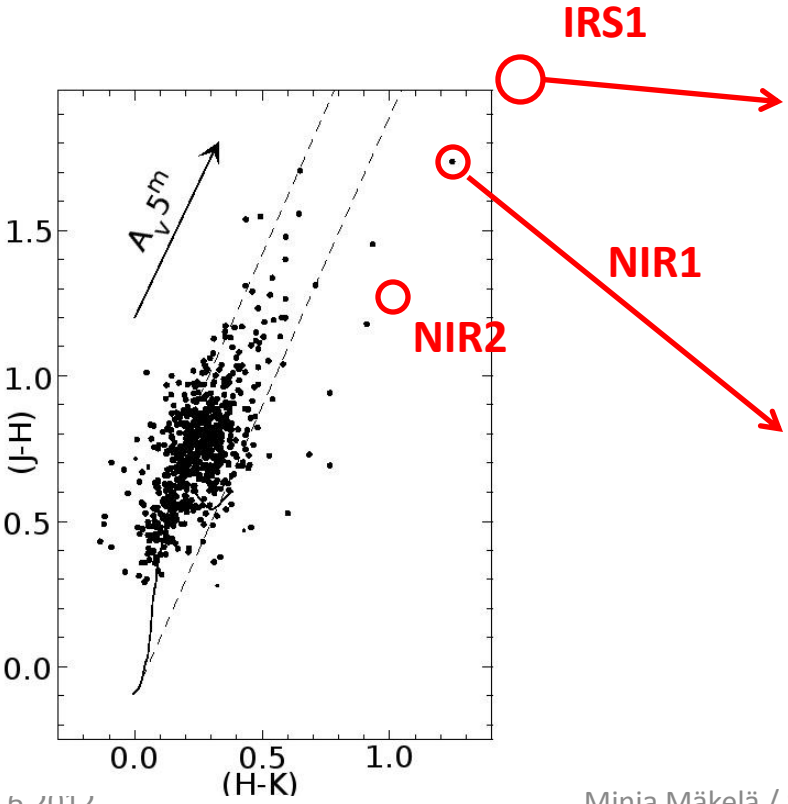
Observations/data

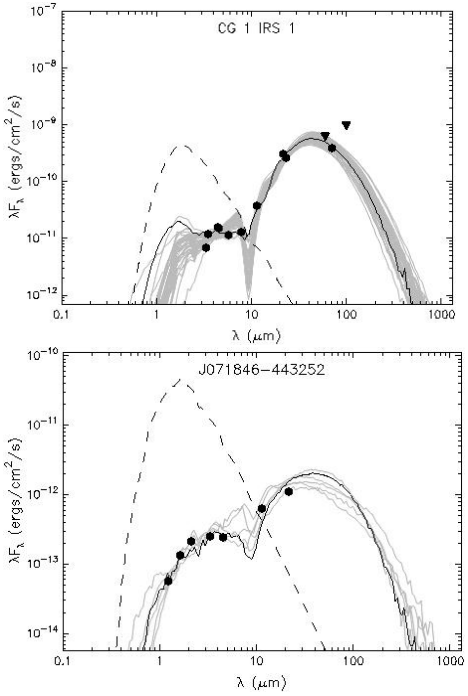
- near infrared: JHKs (NTT/SOFI, IRSF/SIRIUS)
- additional archive data to construct SEDs
- mid/far infrared: WISE and Spitzer images



Photometry

- NIR: color-color diagram
  - NIR excess objects
  - reddening
- multiband: SEDs
  - JHKs + archive data
  - SED fitting web tool by Robitaille et al. (2007)





age ~10^4-10^5 yr
mass ~1 M_{sun}

age ~10^6 yr
mass ~0.5 M_{sun}
distance estimate?

CG formation mechanism

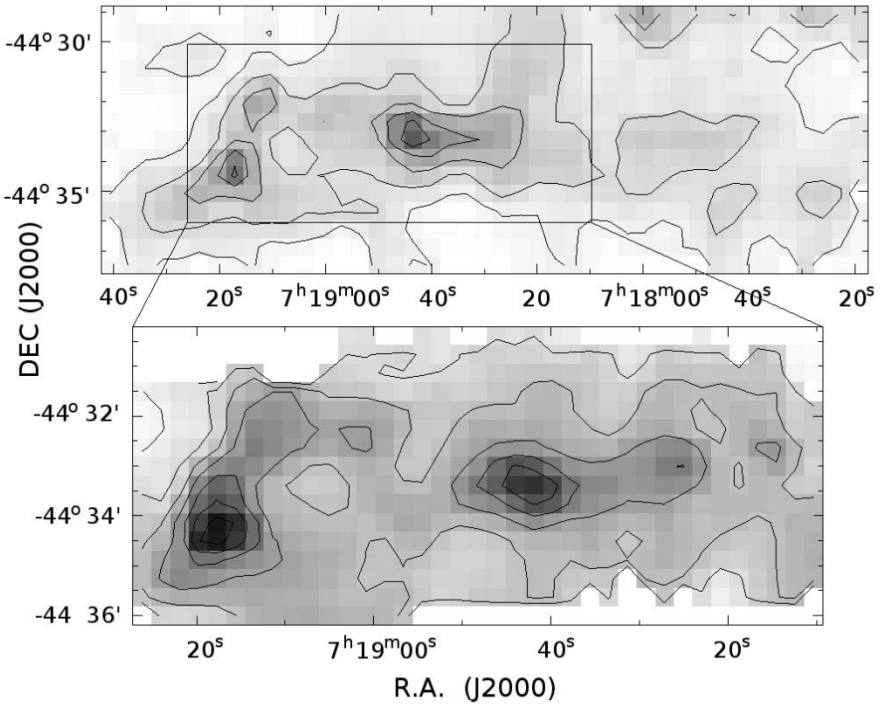
- supernova (SN) blast wave
  - shock wave drives into the cloud and compresses it
  - matter driven mechanically downwind to create a tail
- radiation driven implosion (RDI)
  - UV radiation from an O star photoionizes the original cloud, the shock front compresses it
  - tail formed by radiation and shocks from eroded cloud matter
- computed mass distribution between head and tail
  - SN: about 50-50 in typical case
  - RDI: most matter in the head

Visual extinction & mass distribution

- NICER method
- Av in the head ~8^{mag}, in the middle ~7^{mag}
- fraction of mass in the head
  - SOFI 0.41
  - SIRIUS 0.31

Sounds like the SN case?

Not so simple.



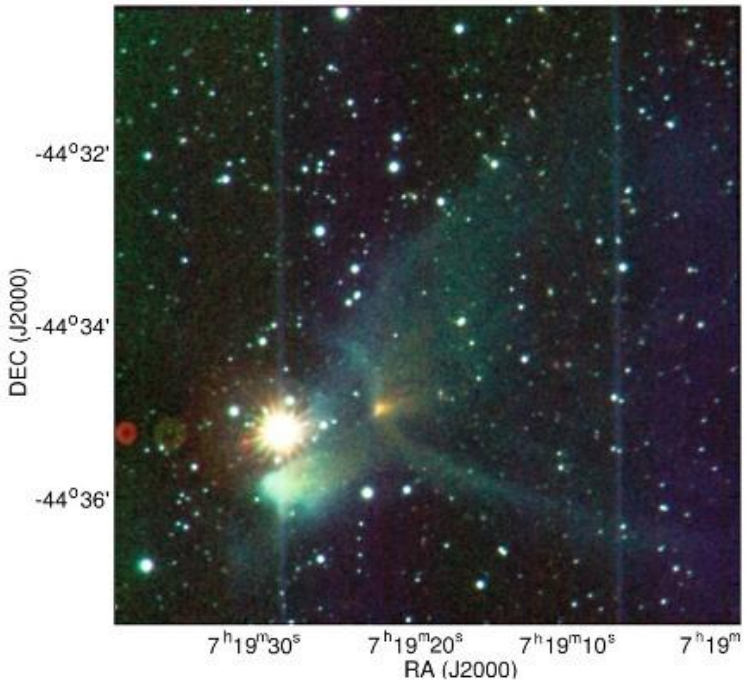
Star formation in CG1

- simulations made for newly-formed CGs, evolution effects like star formation (SF) are not included
- NX Pup born in the cloud ~10^6 yr ago
- IRS1 age ~10^5 yr (class I)

  → two stellar generations

- SF triggered likely by RDI
- SF also modifies mass distribution

  → RDI not a bad candidate

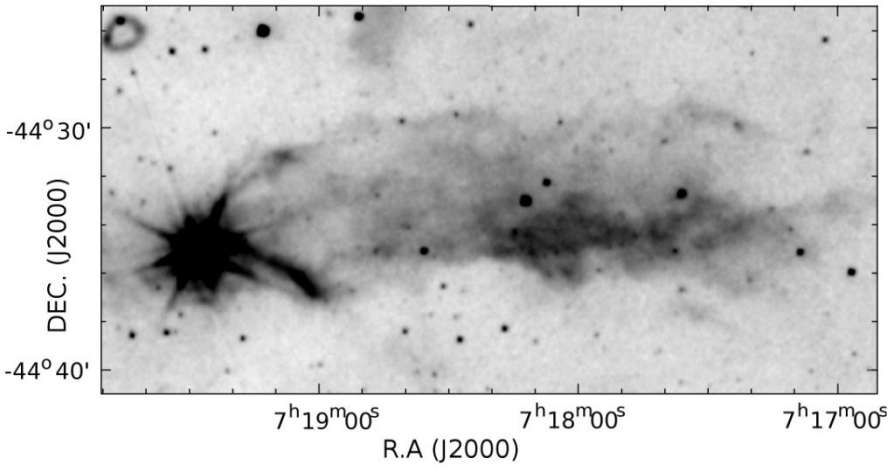


SIRIUS JHKs

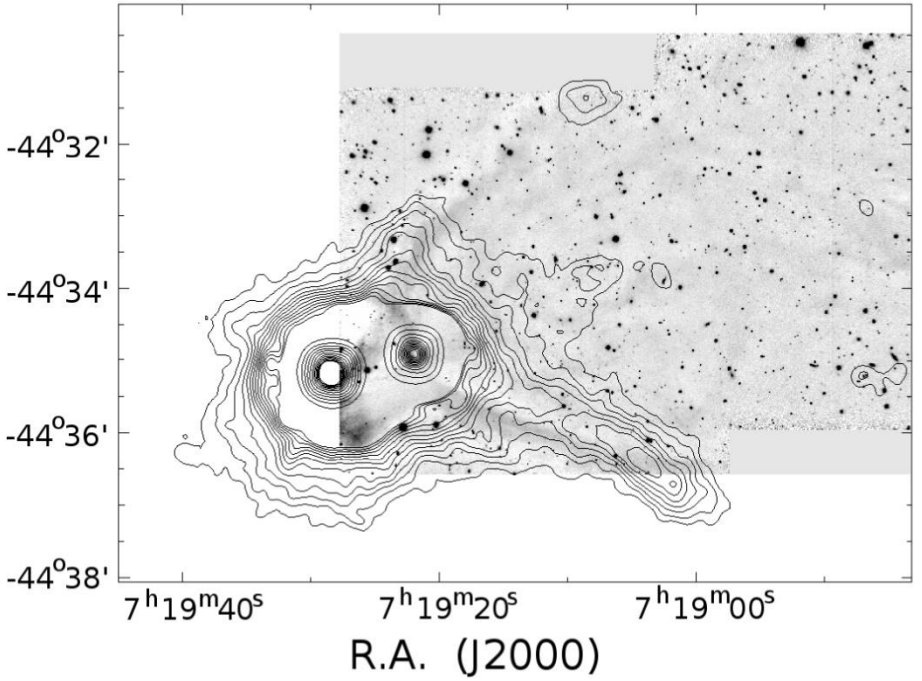
CG1 in WISE images

- WISE filters 3.4, 4.6, 12, 22 µm
- SW filament bright in 12 and 22 µm

12 µm

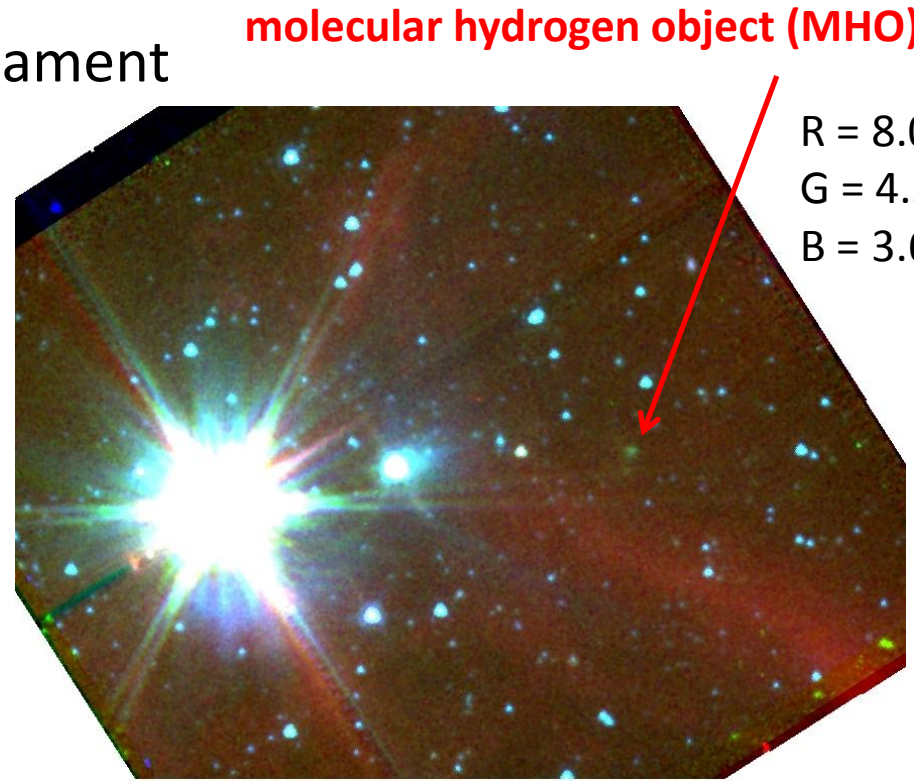


contours 22 µm/image Js



Spitzer: Outflow in CG1?

- 3.6, 4.5, 5.8, 8.0 µm and 24, 70 µm
- 8.0 µm filament = WISE SW filament
- 3.6, 4.5 µm filaments = SOFI filament
- bi-polar outflow, light scatter-ing from cavity walls at 3.6 and 4.5 µm
- MHO object a sign of shock
- but only a weak CO outflow is detected!



Summary

- CG1 too evolved to determine the CG formation mechanism
- the embedded YSO has an outflow
- more observations needed to determine the nature of the outflow