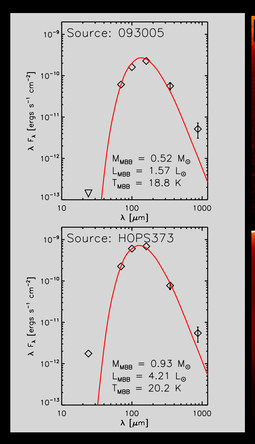
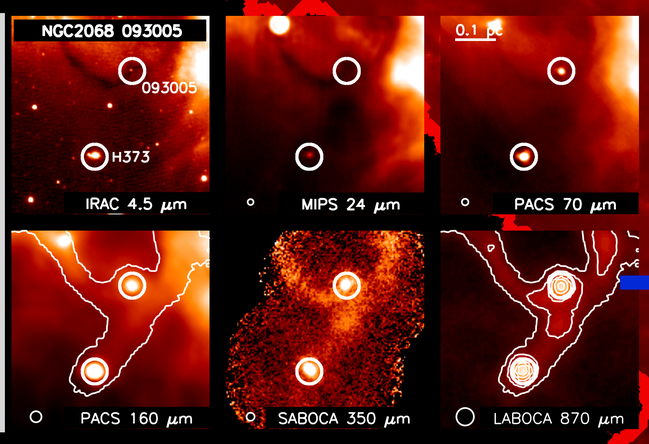
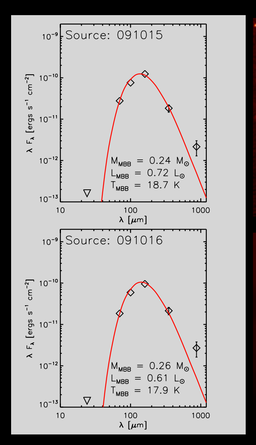
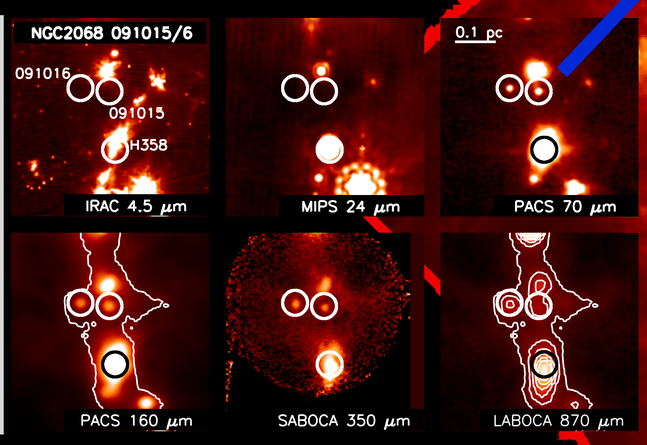
The discovery of extremely young protostars in Orion with Herschel and APEX

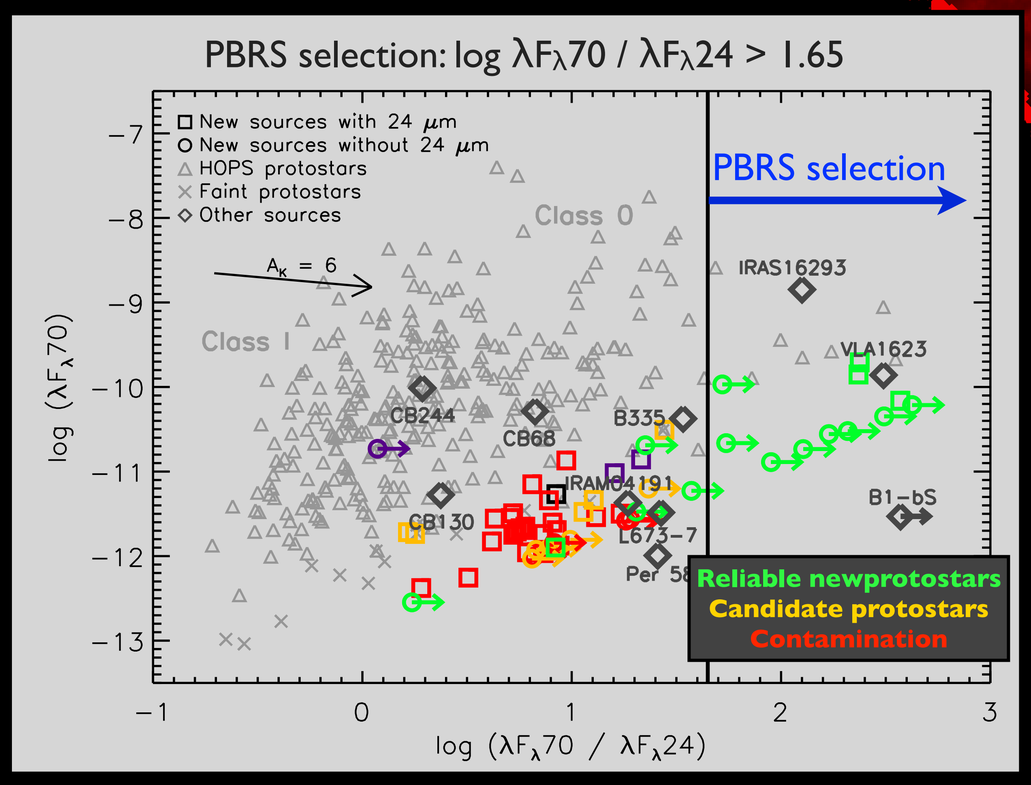
Amy Stutz (MPIA, stutz@mpia.de), John Tobin, Thomas Stanke, S. Thomas Megeath (HOPS P.I.), William Fischer, Thomas Robitaille, Thomas Henning, Babar Ali, James Di Francesco, Elise Furlan, Mayra Osorio, & the HOPS team

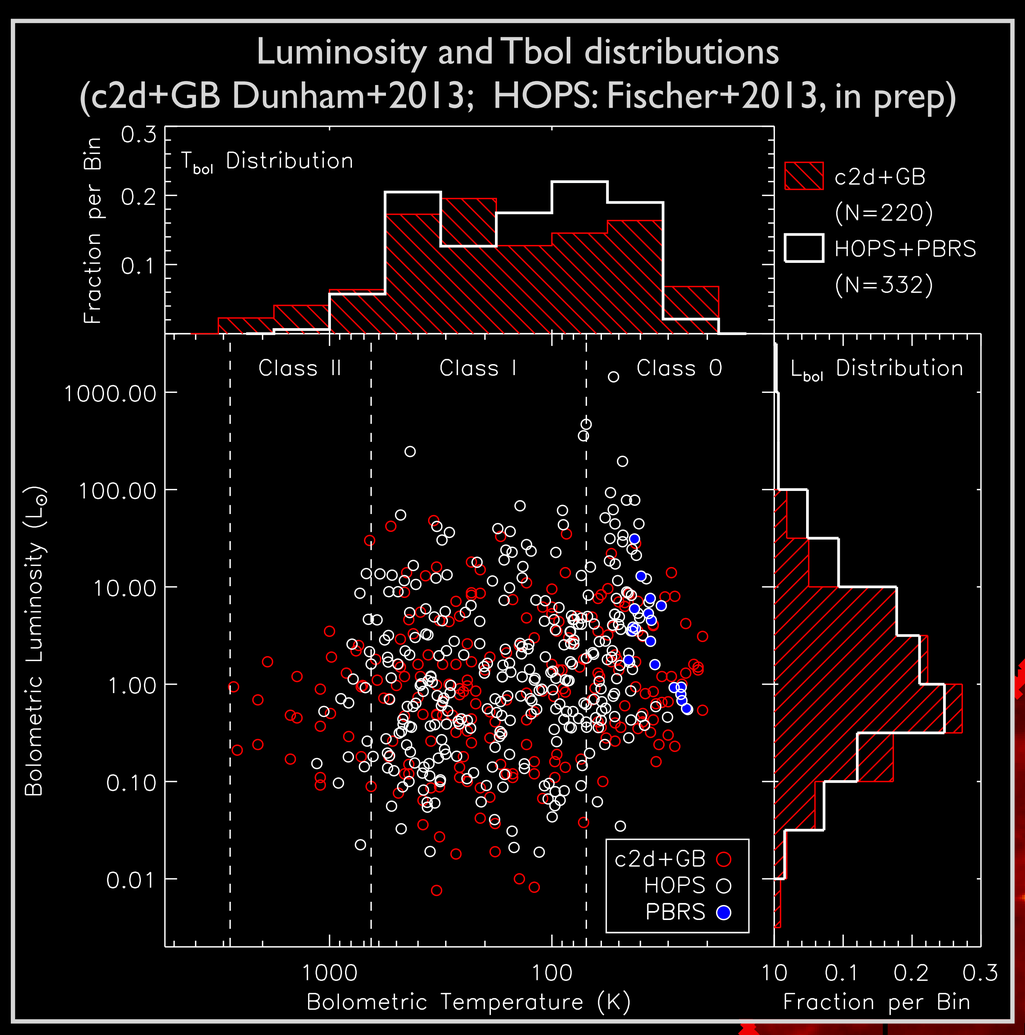












We perform a census of the reddest, and potentially youngest, protostars in the Orion molecular clouds using 24 um - 870 um imaging obtained with the Spitzer, Herschel, and APEX telescopes as part of the Herschel Orion Protostar Survey (HOPS). We find a sample of 15 new extremely red protostar candidates that can reliably identified as protostars (Stutz et al., 2013). Taking the previously known sample of 300 Spitzer protostars and the new sample of 15 Herschel identified protostars together, we find 18 extremely red protostars (i.e., log $\lambda F_\lambda 70$ / $\lambda F_\lambda 24$ > 1.65). These are the reddest protostars known in Orion and we name them "PACS Bright Red sources", or PBRS.

Our analysis reveals that the PBRs sample is composed of Class 0 like sources with very red spectral energy distributions (SEDs; Tbol < 45 K) and large sub-millimeter fluxes (Lsmm/Lbol > 0.6%). Modified blackbody fits to the SEDs provide lower limits to the envelope masses of 0.2 Msun - 2 Msun and luminosities of 0.7 Lsun - 10 Lsun. Based on these properties, and a comparison of the SEDs with radiative transfer models of protostars, we conclude that the PBRs are most likely extreme Class 0 objects distinguished by higher than typical envelope densities and possibly high mass infall rates. We estimate the ages of the PBRs to be between 5000 and 25000 years. We find that the fraction of PBRS is more than 5 times higher in the Orion B cloud than in Orion A; this may be due to differences in the star formation histories or in the star forming environment.

HERSCHEL ORION PROTOSTAR SURVEY

The PBRS were discovered in the Herschel Orion Protostar Survey (HOPS) data. HOPS is a 200 hr open time key programme.

L1622

NGC2068/
NGC2071

Orion B

NGC2024/
NGC2023

2 deg / ~7 pc

HOPS Sources
PBR Sources
HOPS coverage

OMC/
ONC

Orion A

L1641

DFG Priority Program 1573 ISM-SPP Interstellar Medium

Protostars & Planets VI Heidelberg 2013

Figure adapted from Stutz et al. (2013)
Background image: Gould Belt SPIRE 500 um; e.g., Schneider et al. (2013)