STAR FORMATION IN GIANT COMPLEXES: THE CAT'S PAW NEBULA

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NGC 6334, the Cat's Paw Nebula, is a 10^6 M$_\odot$ **molecular cloud**, one of the most massive known clouds in the Galaxy. It hosts the **youngest massive cluster complex** within 2 kpc of the Sun, and is therefore an ideal laboratory to investigate the onset and early evolution of star formation in an environment **comparable to that of massive, extra-galactic** complexes. Using multi-wavelength data, we are conducting the most sensitive and most complete characterization of this unique region to date.

How does an entire cloud *know* when to form stars?

About **ten individual pockets of star formation**, most in different stages of early evolution but all coeval to within ~5 Myr, lie on a 15 pc long molecular ridge in NGC 6334. There is no evidence for sequential star formation in the complex, suggesting an **external trigger** for the coordinated large scale star formation activity.

Which stars populate a galaxy?

Massive star clusters contribute as much mass to the stellar population of a galaxy as the most numerous low-mass clusters [e.g., Lada & Lada 2003]. Do their stars remain locked in their parent clusters, or rather dissolve into the field? NGC 6334 is young enough to teach us about the timescales and mechanisms for **gas dispersal** and global *vs.* local **star formation efficiencies**.

Is star formation a local or a global process?

Is the mass distribution of the stars produced by a cloud a global property of the cloud, determined prior to star formation, or is it a local characteristic of each individual star formation event? What is the stellar **IMF of the whole cloud**, and how does it compare to the IMF of the individual clusters it forms?

What happens to star formation when a supernova occurs?

Considering the short lives of massive stars, this is bound to happen in all massive star forming sites early in their lives. Our preliminary data suggests that one of the characteristic optical bubbles of the Cat's Paw may be a **supernova remnant**. Inside there is a population of young, X-ray active stars.

Goals

- Characterize the **stellar population** of the cluster complex from the most massive stars down to 0.5 M$_\odot$.
- Characterize the **cloud** and its interaction with the young stars.
- Understand the **formation and early evolution** of stars and clusters in massive complexes.
- **Bridge the gap** between our understanding of galactic and extra-galactic star formation.

Data

- **VISTA** JHK large scale survey
- **HAWK-I** HK deep photometry
- **NACO** JHKL [selected regions]
- *Spitzer* 3.6 - 24 μm
- *Herschel* 250 - 500 μm
- **MALT90** ~90 GHz
- *Chandra* X-ray
- **FORS2** optical spectra [SNR candidate]

0.5 pc   0.5 pc   1 pc   1 pc   2 pc

VISTA JHK

Very hot core
X-ray/IR cluster
Water, OH, methanol masers
High-velocity outflows
Line-rich spectra

VISTA JHK
Older cluster in the complex

CTIO Hα, OIII, SII
Supernova remnant candidate

VISTA JHK
X-ray/IR cluster
Water, OH, methanol masers
Outflows

14 pc

VISTA JHK
X-ray/NIR cluster
Massive embedded protostar
Bipolar nebula
Ammonia, OH, methanol, water masers

Gas cleared up by embedded stars

Herschel 250 μm + *Spitzer* 5.8 μm

VISTA JHK

HAWK-I K
Outflows from massive protostar

Gas cleared up by embedded stars

60 pc

Herschel 250 μm + *Spitzer* 5.8 μm

VISTA JHK

NACO K$_s$

Outline of the HAWK-I (J)HK mosaic