The HETG Orion Project:

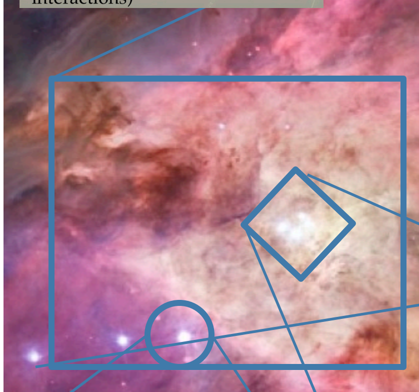
Young Hot Stars, Cool PMS Stars, Coronae and Accretion, Proto-planetary Disks, Giant Flares

MKI

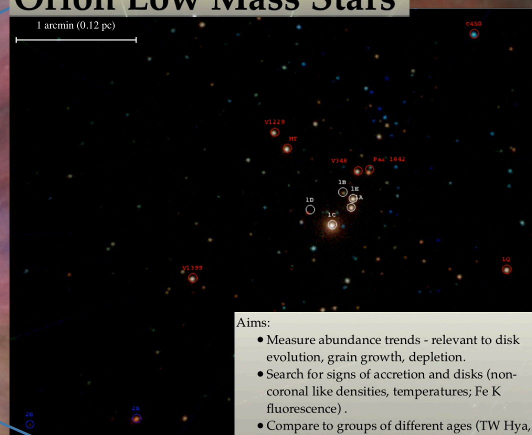
Obtain high-quality high-resolution X-ray spectra in the Orion Nebula Cluster (ONC)

To study:

- ☆Massive star signatures of winds, shocks, magnetic activity
- ☆Detect accretion or coronal activity in pre-main-sequence stars
- ☆Abundance trends, activity trends with stellar type
- ☆Variability (flares, star-star interactions)



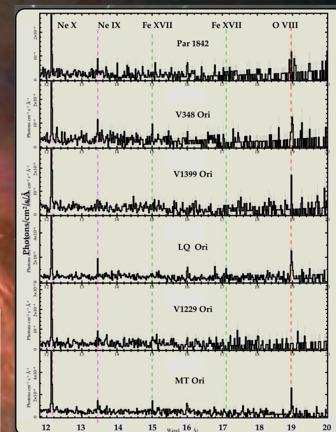
Orion Low Mass Stars

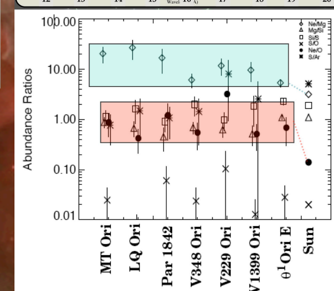


Aims:

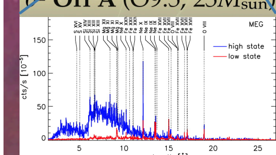
- Measure abundance trends - relevant to disk evolution, grain growth, depletion.
- Search for signs of accretion and disks (non-coronal like densities, temperatures; Fe K fluorescence) .
- Compare to groups of different ages (TW Hya, Taurus).

Need line-based analysis to obtain a good model coronal temperature distribution - key to abundance determinations.



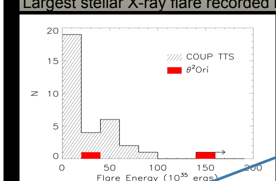


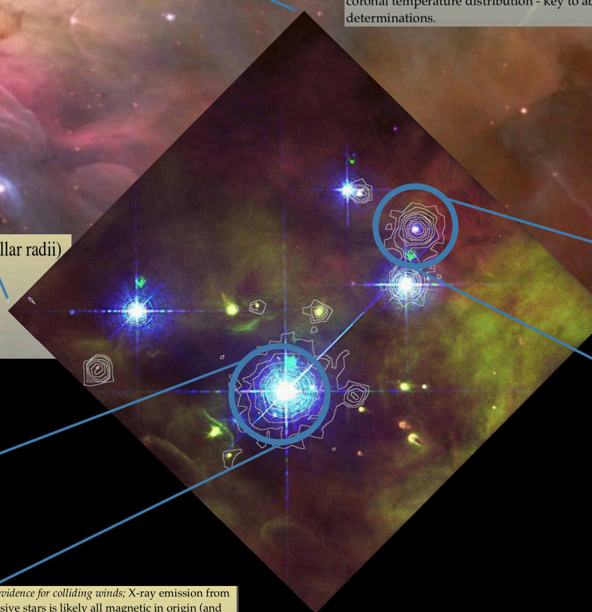
θ^2 Ori A (O9.5, 25M_{sun})



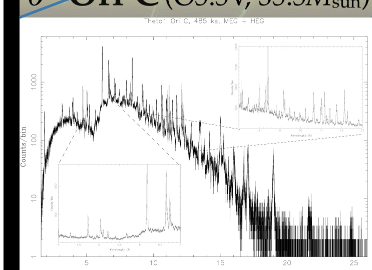
Triplets place the emission close to the photosphere (<3 stellar radii)
Lines, slightly broadened.
Similar to magnetically confined wind.
(Definitely NOT a colliding wind.)

Largest stellar X-ray flare recorded in Orion





θ^1 Ori C (O5.5V, 35.5M_{sun})



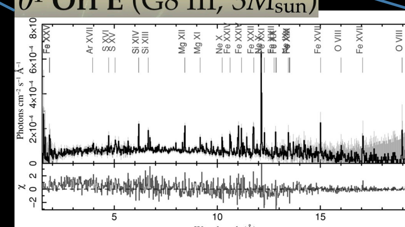
No evidence for colliding winds; X-ray emission from massive stars is likely all magnetic in origin (and some from confined winds).

Abundance trends: *High Ne, low Fe, regardless of mass.* Ne/O might be high - (requires accurate determination of absorption).
(~1, vs 0.17 for solar vs 0.4 for typical stellar coronae)

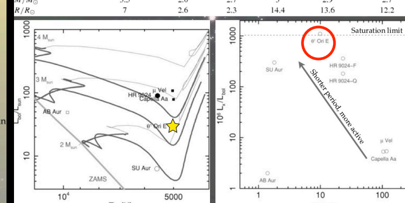
θ^1 Ori A and θ^1 Ori D have very different X-ray luminosity, despite similar intrinsic characteristics. Why? Environmental? Magnetic nature?

Why is the ONC so different from other regions of massive star formation, having fewer and less extreme massive stars?

θ^1 Ori E (G8 III, 3M_{sun})



Quantity	θ^1 Ori E [a]	SU Aur	AB Aur	μ Vel	HR 9024[b]	Capella Aa[c]
Spec. Type.	G8 III+G8 III	G2 IV	A0	G5 III	G1 III	G8 III
T_{eff} (K)	5012	5550	9750	5030	5530	5000
Age (My)	0.5	4	4	360	Post-ms	525
$M/M_\odot$	3.5	2.0	2.7	3	2.9	2.7
$R/R_\odot$	7	2.6	2.3	14.4	13.6	12.2



Spectroscopic binary two equal mass G III stars, 2-3 M_{sun}, 9.9 day period (Herbig & Griffin 2006).

2nd brightest ONC star in X-rays.
Exposure: 260 ks

RARE evolutionary state: 0.5-1Myr, 3M_{sun}

X-ray emission appears to be *coronal:* hot (10-30 MK), low-density (<10^{12} cm^{-3}): magnetically confined.

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