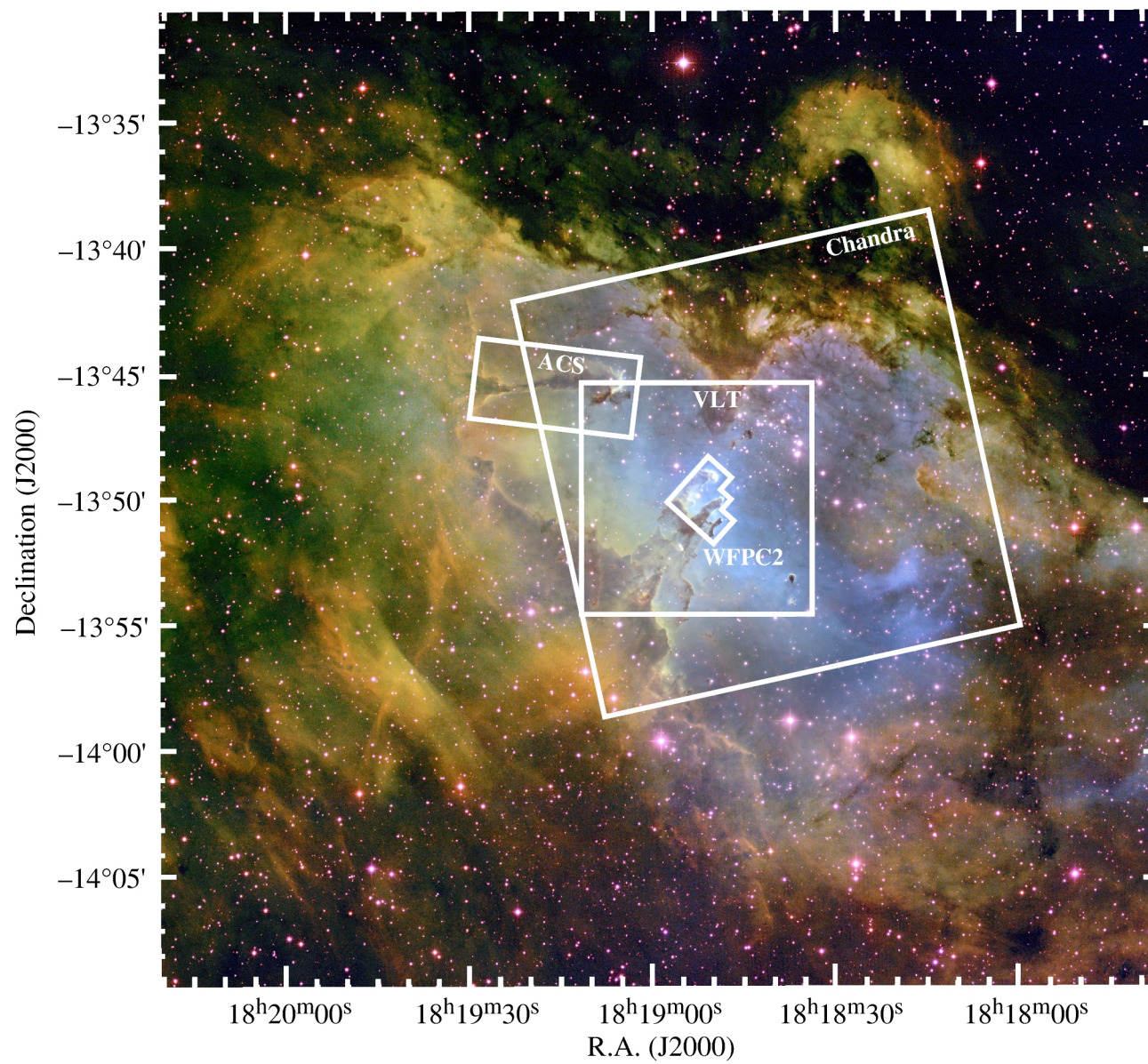


Chandra and VLT Observations of Young Stellar Objects in the Eagle Nebula

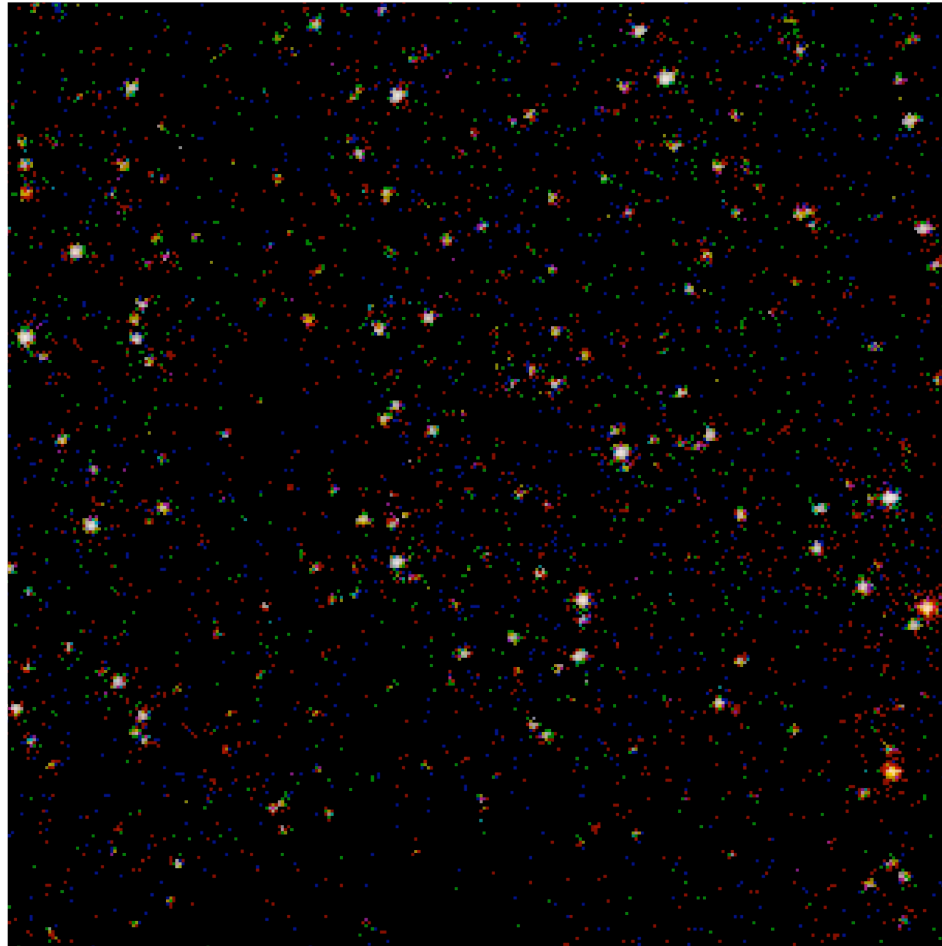
Jeffrey Linsky – University of Colorado
Marc Gagné – West Chester University
Anna Mytyk – West Chester University
Mark McCaughren – Exeter University
Morten Andersen – University of Arizona

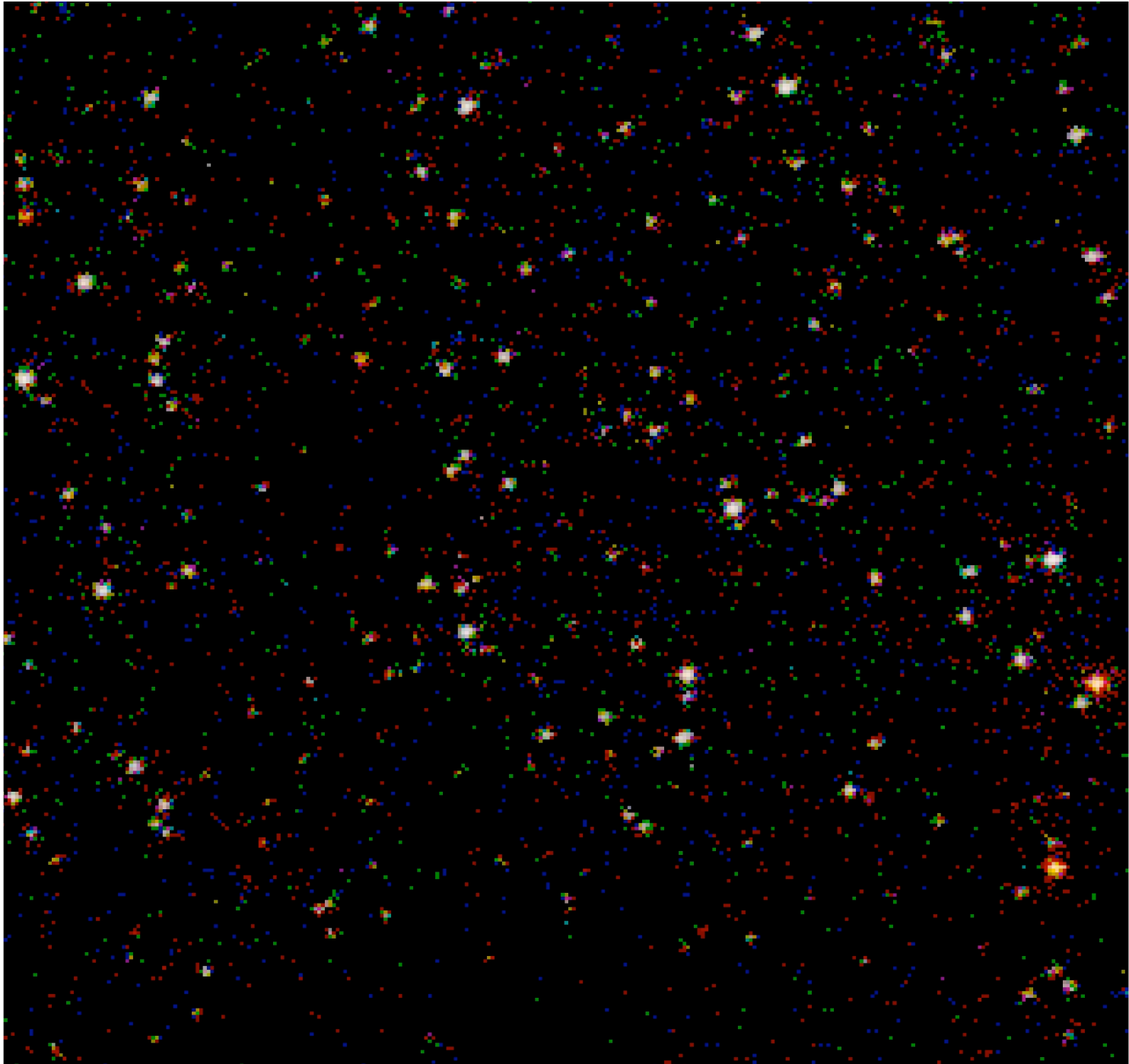
NGC 6611 and the Eagle Nebula

- NGC 6611 is a young star cluster (2 Myr) at 2.0 kpc.
- Eagle nebula is a small portion of field
- UV radiation from HD 168076 (O3-5 star 2 pc from tip of pillars) and other O stars photoevaporate the pillars and EGGs.
- Eagle nebula (M16) star forming region
- Dark columns of dust and cold molecular gas (“Pillars of Creation” or “Elephant Trunks”)
- WFPC2 image shows EGGs (evaporating gaseous globules) by Hester et al. (1996)



77-ks Chandra ACIS-I image (2.5'x2.5' core of NGC 6611):
0.5-1.5 keV; 1.5-2.5 keV; 2.5-7 keV



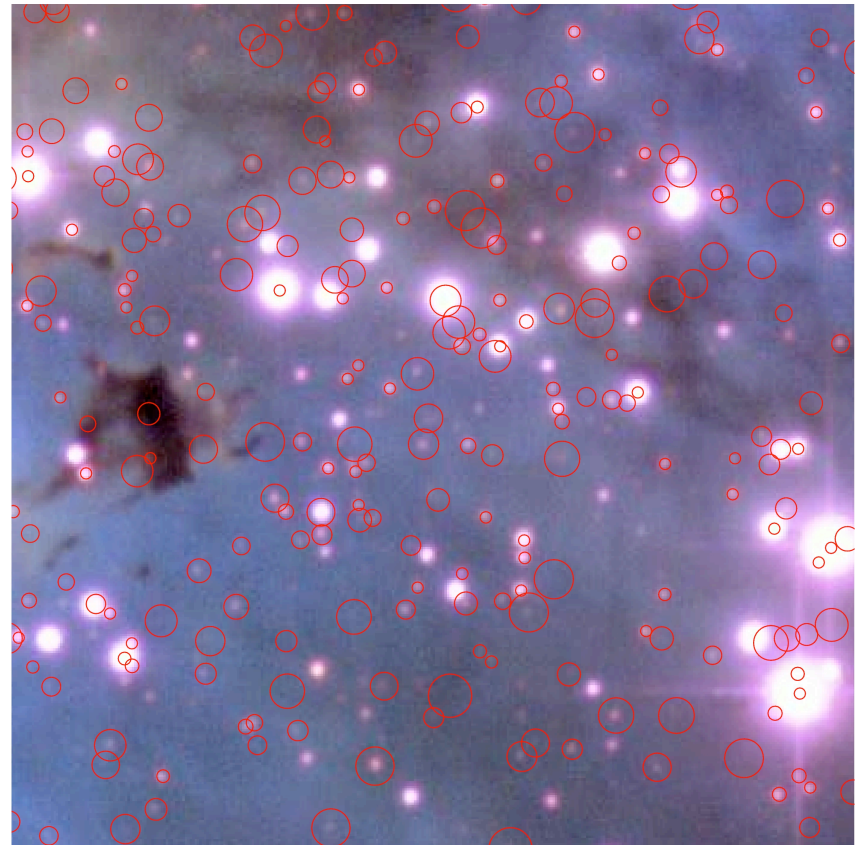


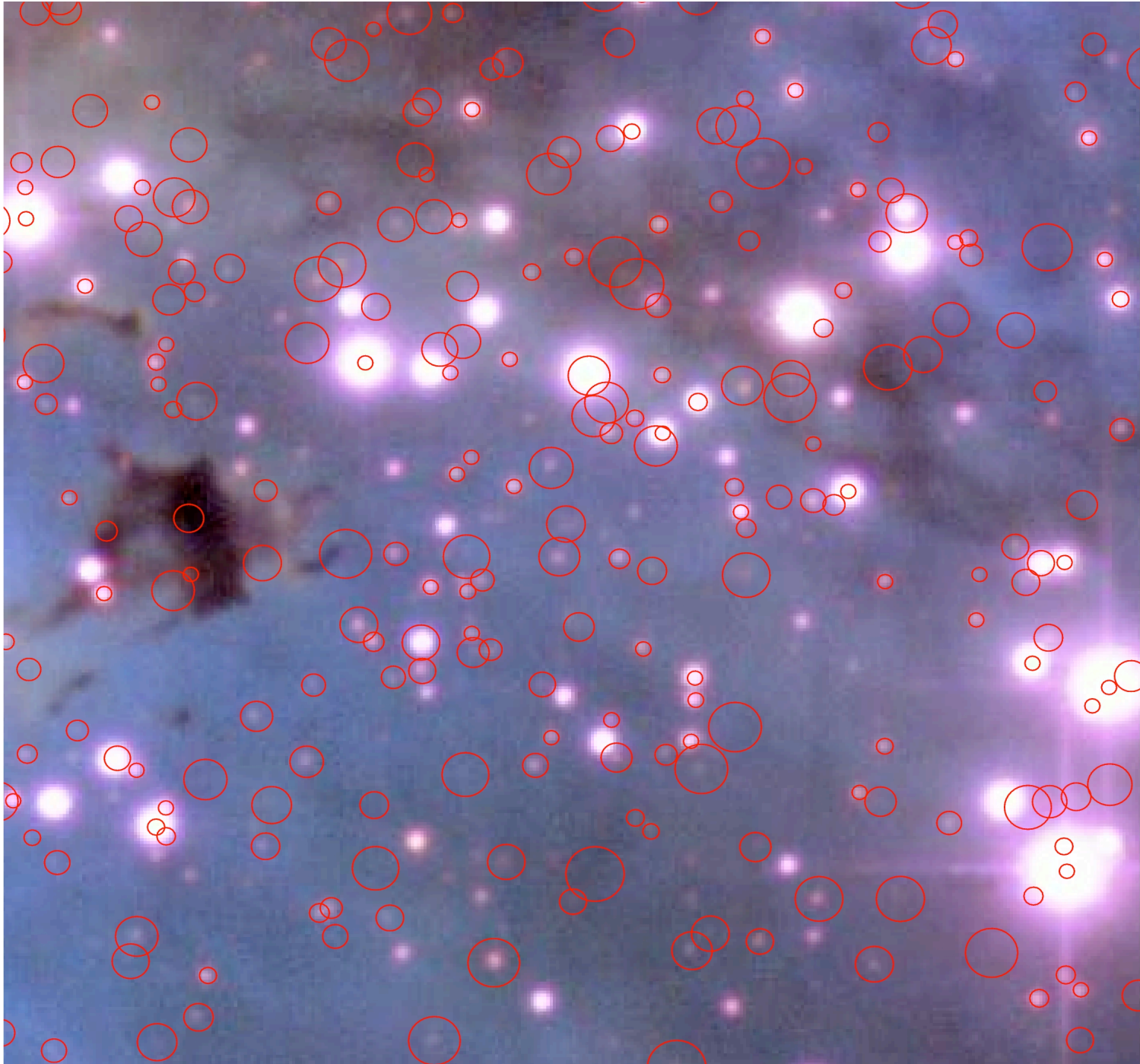
What Chandra detected

- 1103 X-ray sources in the 17'x17' field above a threshold of 6 counts ($\log L_x \approx 29.8$). Nearly all coincident with K band (2.2 μ) IR sources.
- <100 are foreground or background sources.
- Detected 11/11 O stars, 22/40 early-B stars, 4/13 late-B stars, and 3/7 A stars.
- Most X-ray sources are intermediate to low mass PMS stars.

77-ks Chandra ACIS-I image of the core of NGC 6611

- 2.5'x2.5' field of view
- NOAO 0.9m optical image (S II, H_α, O III)
- X-ray detection circles (radius proportional to source positional uncertainty).



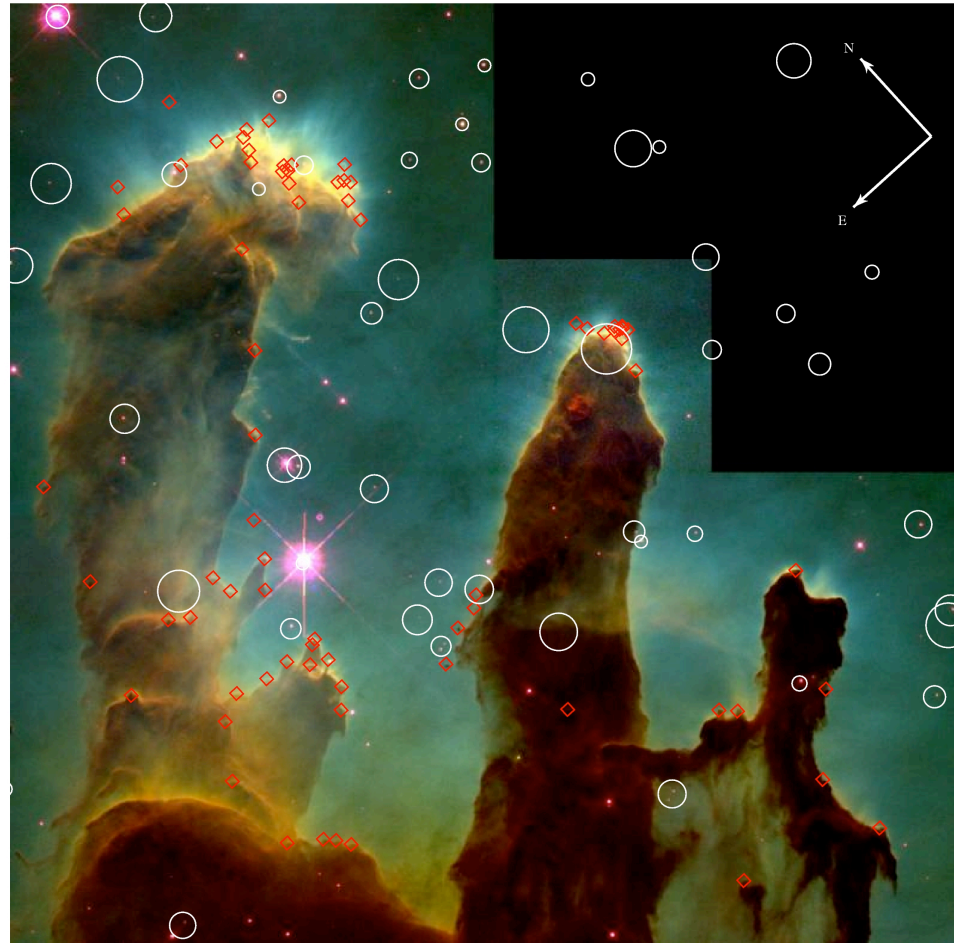


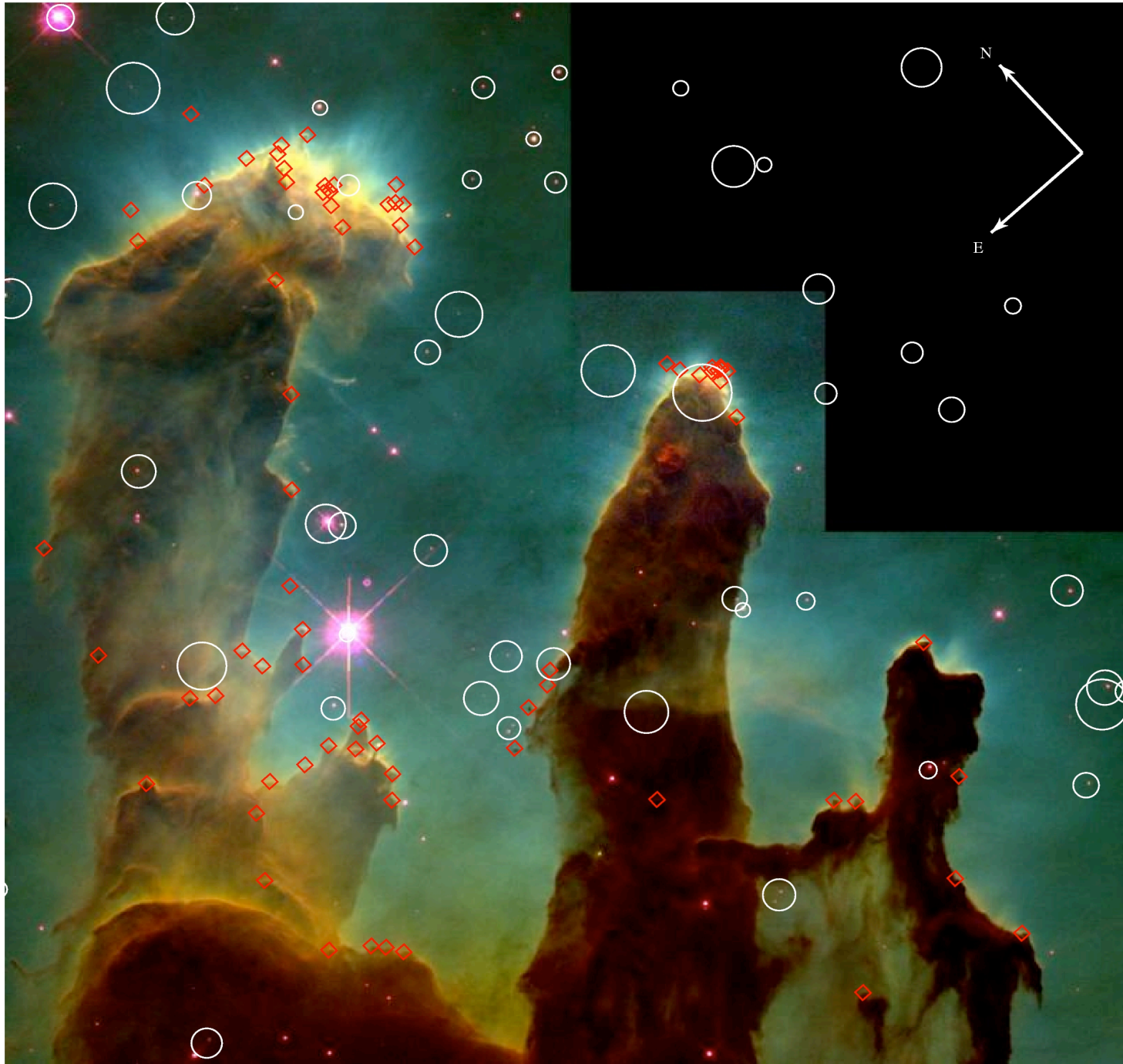
VLT ISAAC K_sHJ_s image of the 2.5'x2.5' core of NGC 6611
with X-ray detection circles superimposed





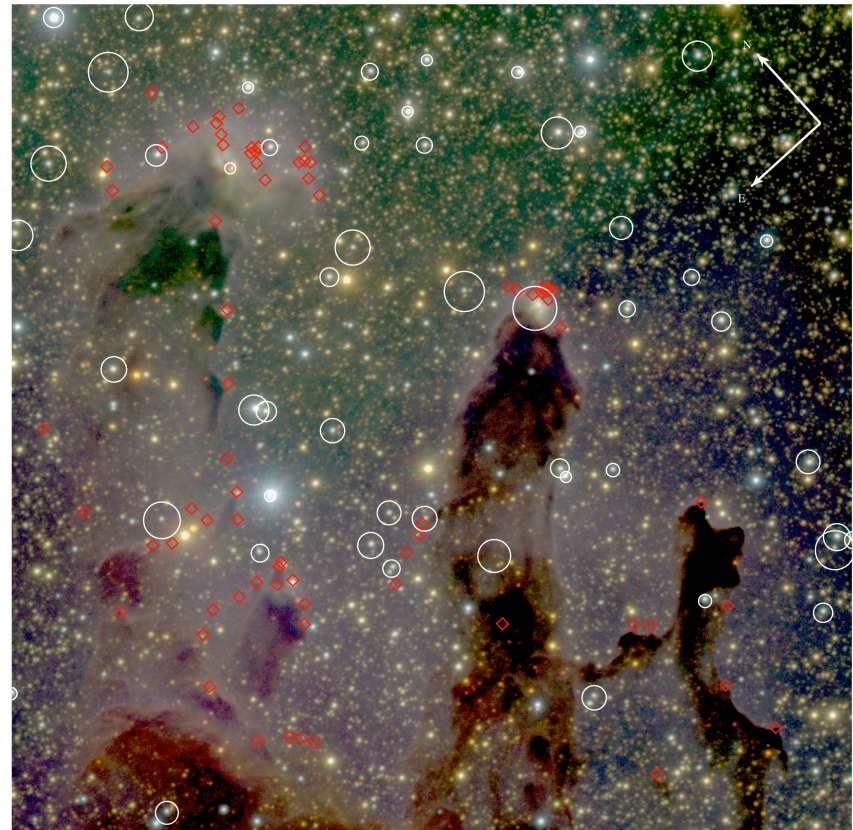
HST WFPC2 image (H_{α} , S II, O III) of the 2.5'x2.5' core of NGC 6611: 3 pillars, EGGS (diamonds) and X-ray circles

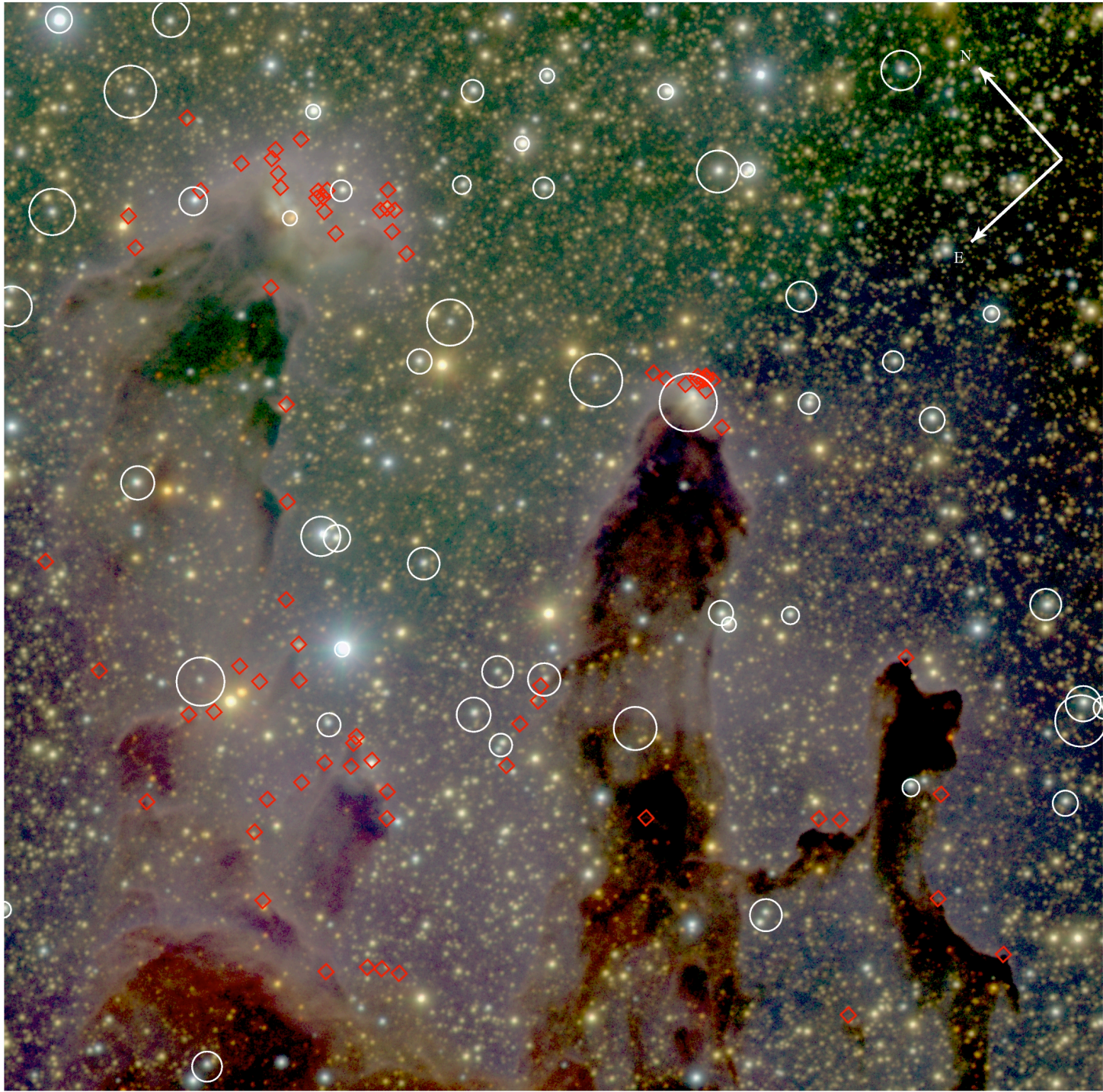




Are the EGGs (Evaporating Gaseous Globules) fertile?

- VLT ISAAC **KsHJs** image of 2.5'x2.5' core of NGC 6611.
- Hester et al (1996) found 73 EGGs (**diamonds**): H₂
- McCaughrean+Andersen (2002) found 11/73 are point IR sources (0.02-1.0 M_{sun}).
- X-ray detection circles
- 0/40 Chandra sources agree with EGGs ($\log L_x < 29.8$). In Orion 0.35-1.0 M_{sun} YSOs have $\log L_x = 28.5-30.5$. **Go deeper!**
- 39/40 Chandra sources coincident with near-IR source (VLT or 2MASS).





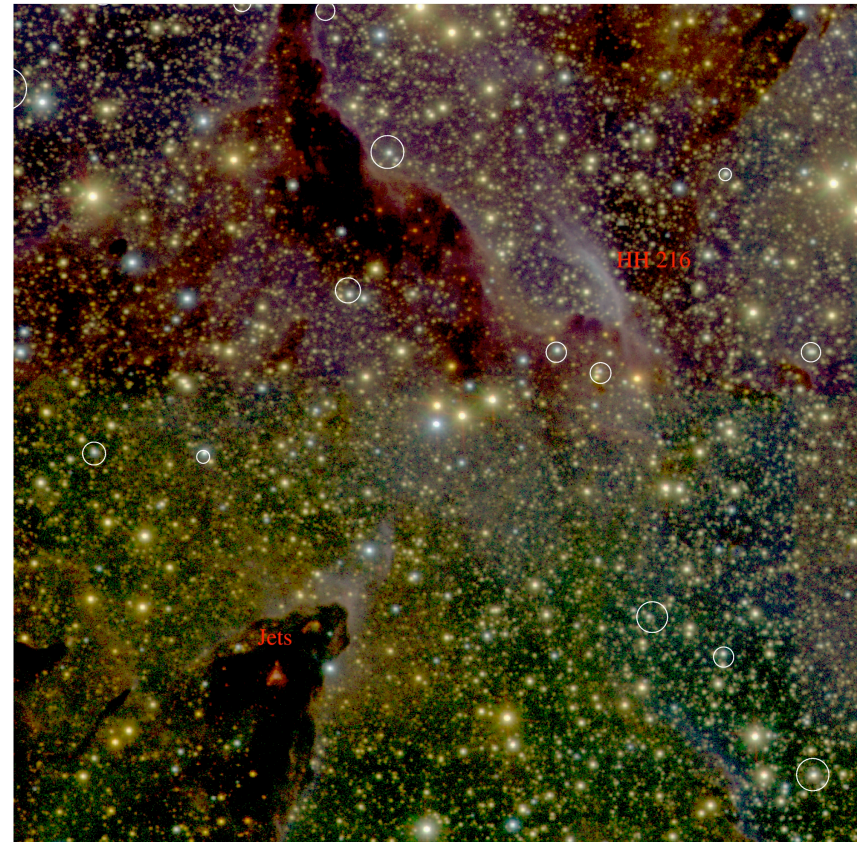
The massive YSO M16ES-1

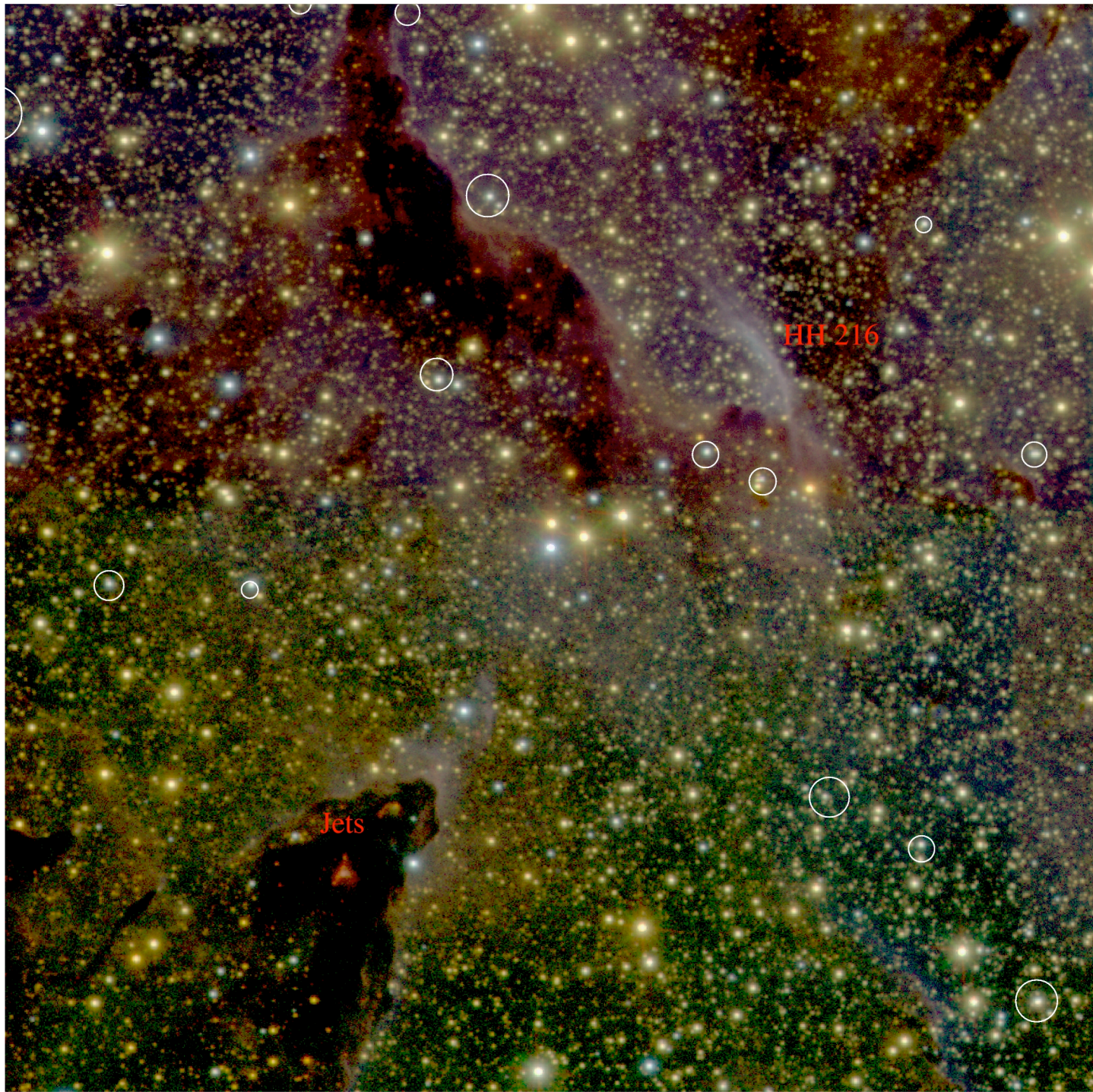
- Very hard X-ray source at the head of Pillar 1. Not coincident with an optical source or an EGG.
- Probably an 4-5 M_{sun} YSO with a disk.
- If $A_V \approx 27$, $\log L_x = 32.2$ (greater than any single star in Orion), $\langle E \rangle = 3.3 \pm 0.2$ keV.
- $\log L_x/L_{\text{bol}} = -3.7$, so likely a magnetically active YSO (like the MCP star ___ Ori C?).

HH216 is an X-ray source:

$\log L_x \approx 30.0$ erg/s and $\langle E \rangle = 1.9 \pm 0.6$ keV

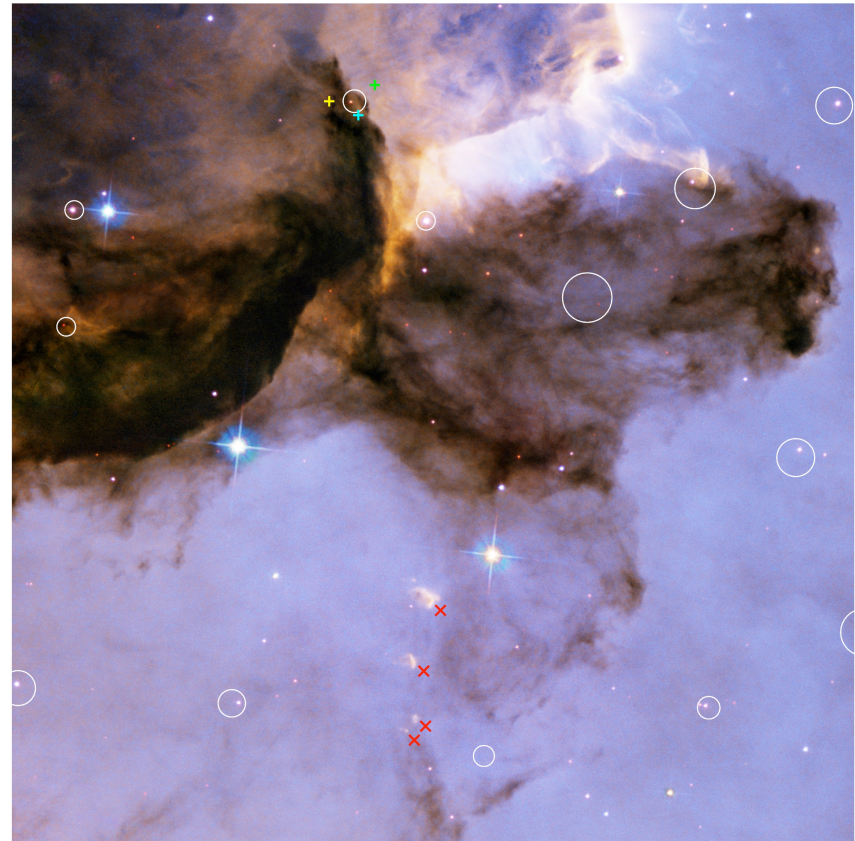
- VLT ISAAC **KsHJs**
2.5'x2.5' image with
Pillar 4.
- X-ray detection circles
- HH216 detected with
8 counts $\sim 1''$ behind
the bow shock.
- Jets (reddened) and
unseen central star
are not X-ray sources.

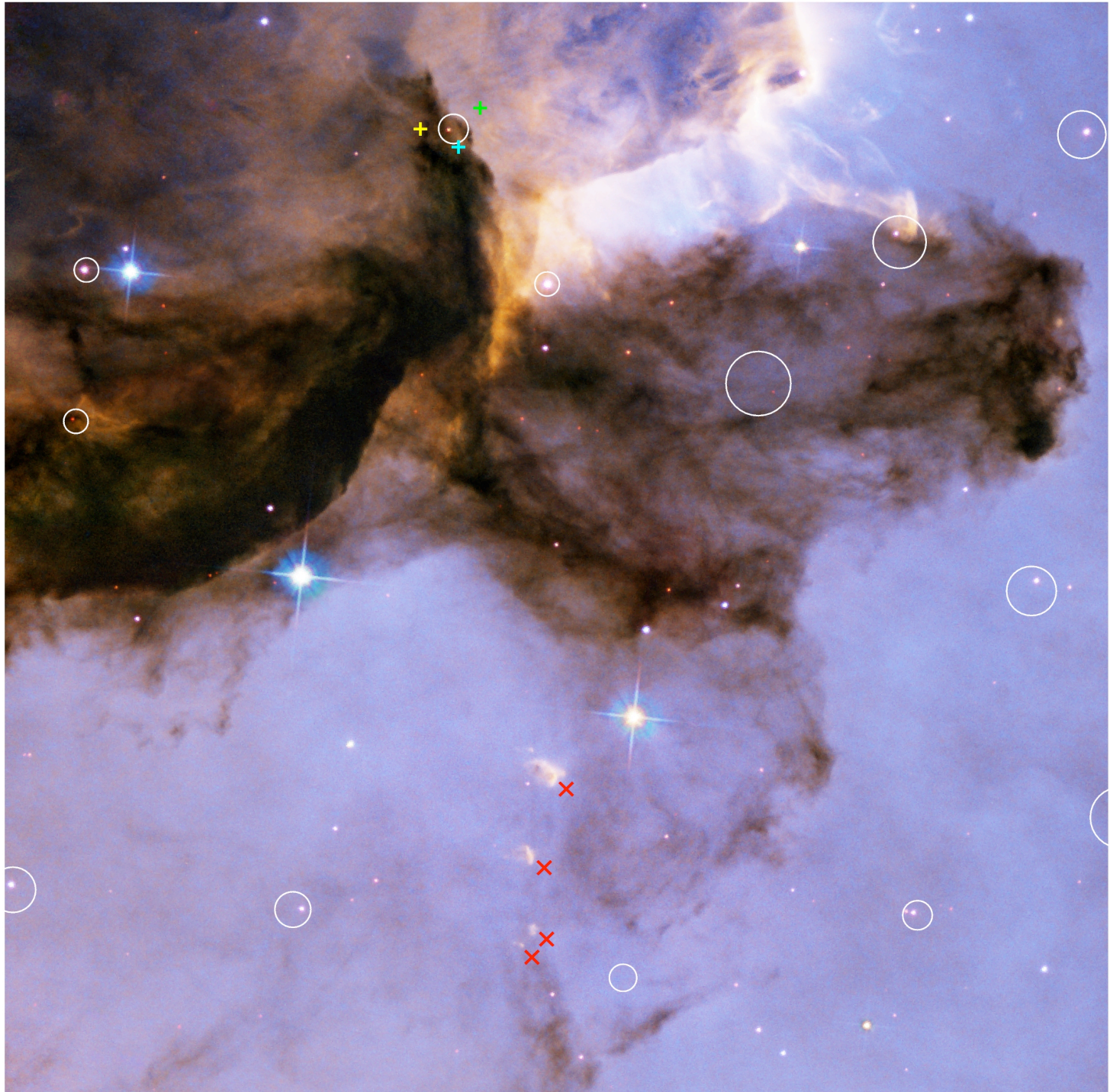




X-ray source located near three 22-GHz water masers

- HST ACS 1.5'x1.5' image (H_α+N II+I, V, O III+B) of Pillar 5.
- X-ray detection circles
- Water masers: +, +, +
- 65 ACIS count source near water masers and perhaps coincident.





Summary and Conclusions

- First high angular resolution X-ray observation of NGC 6611 (2 Myr) detected about 1000 cluster sources. Most are uncatalogued Class II or III T Tauri stars.
- Detected sources have L_x similar to YSOs in other clusters of similar age.
- The EGGs detected in H₂ and 11 near-IR point sources are not X-ray sources above $\log L_x=29.8$. **Surprise!**
- Few X-ray sources are detected in or near the photoevaporating Pillars. **Youngest protostars are not X-ray sources or too deeply embedded to detect in 77 ks?**
- HH216 bowshock detected at $L_x \approx 30.0$.
- M16ES-1 at tip of Pillar 1 is the most luminous source: $\log L_x=32.2$, $\langle E \rangle=3.3$ keV (very hard). A young Ori C?