X-raying a Cold, Dark Dragon...

Matthew S. Povich (NSF Postdoctoral Fellow),
Leisa K. Townsley, & Wesley Orbin
The Pennsylvania State University
3.6 µm (stars) • 8.0 µm (PAHs) • 24 µm (warm dust)

Elmegreen & Lada (1976, 1977)
Povich et al. (2009); Povich & Whitney (2010)

\[ d = 2 \text{ kpc}^* \]

Xu et al. (2011)
1216 young stellar objects (YSOs) detected via IR excess emission, including:
- 580 disk-dominated (Stage II/III)
- 442 envelope-dominated (Stage 0/I)
- 194 ambiguous
Hot plasma within the dragon

MIPSGAL 24 μm (~100 K)
Hard X-rays (2–8 keV; ~10⁸ K)
Soft X-rays (0.5–2 keV; ~10⁷ K)

840 X-ray sources
474 YSOs in ACIS FOV

100 ks Chandra/ACIS observation, July 2011 (PI M. S. Povich)
X-rays from Young Stars

• Pre-main-sequence (PMS) stars
  – Magnetic reconnection flares produce hard (>2 keV) X-rays (e.g. Preibisch et al. 2005).

• Massive stars (O and early B types)
  – “Microshocks” in strong stellar winds produce soft (<1 keV) X-rays (Lucy & White 1980).
  – More exotic mechanisms (Colliding wind binaries? Magnetically channeled wind shocks?) produce hard (>1 keV) X-rays (e.g. Gagné et al. 2011).

• Intermediate-mass main-sequence stars
  – No known source of strong X-ray emission (no convection-driven dynamos to produce flares, winds are not strong enough).
  – X-ray emission associated with intermediate-mass stars is usually attributed to the presence of a lower-mass companion (e.g. Evans et al. 2011).
Stellar Mass Functions from Spectral Energy Distribution (SED) Modeling

$3 \, M_\odot = A_0 \, V \, \text{star}$

$A_V < 40 \, \text{mag sample:}$
- 246 YSOs (disks)
- 178 X-ray PMS stars ("diskless")

Kroupa IMF extrapolated to $0.1 \, M_\odot$ yields $>5,000 \, M_\odot$

$\Gamma_{\text{YMF}} = 3.3 \pm 0.7$

$\Gamma_{\text{IMF}} = 1.3 \pm 0.7$

Where are the $O$ stars??
Summary

• As Povich & Whitney (2010) found, M17 SWex is a very active star-forming region. Central cloud region alone hosts >3 times the population of the Orion Nebula Cluster but no early O stars.*

• X-ray observations reveal >100 intermediate-mass, pre-main-sequence stars that lack inner disks (intrinsic X-ray emission?).

• Does M17 SWex represent a distinct mode of distributed, intense star formation? Is this the precursor to a scaled OB association?

* Caveat: The distance to the cloud may instead be 1 kpc (Sato et al. 2010)—gotta love Galactic astronomy!
Appendix: Probabilistic H-R Diagrams for M17 SWex