



The breath of the  
**Arches Cluster** and its impact  
on nearby Molecular Clouds

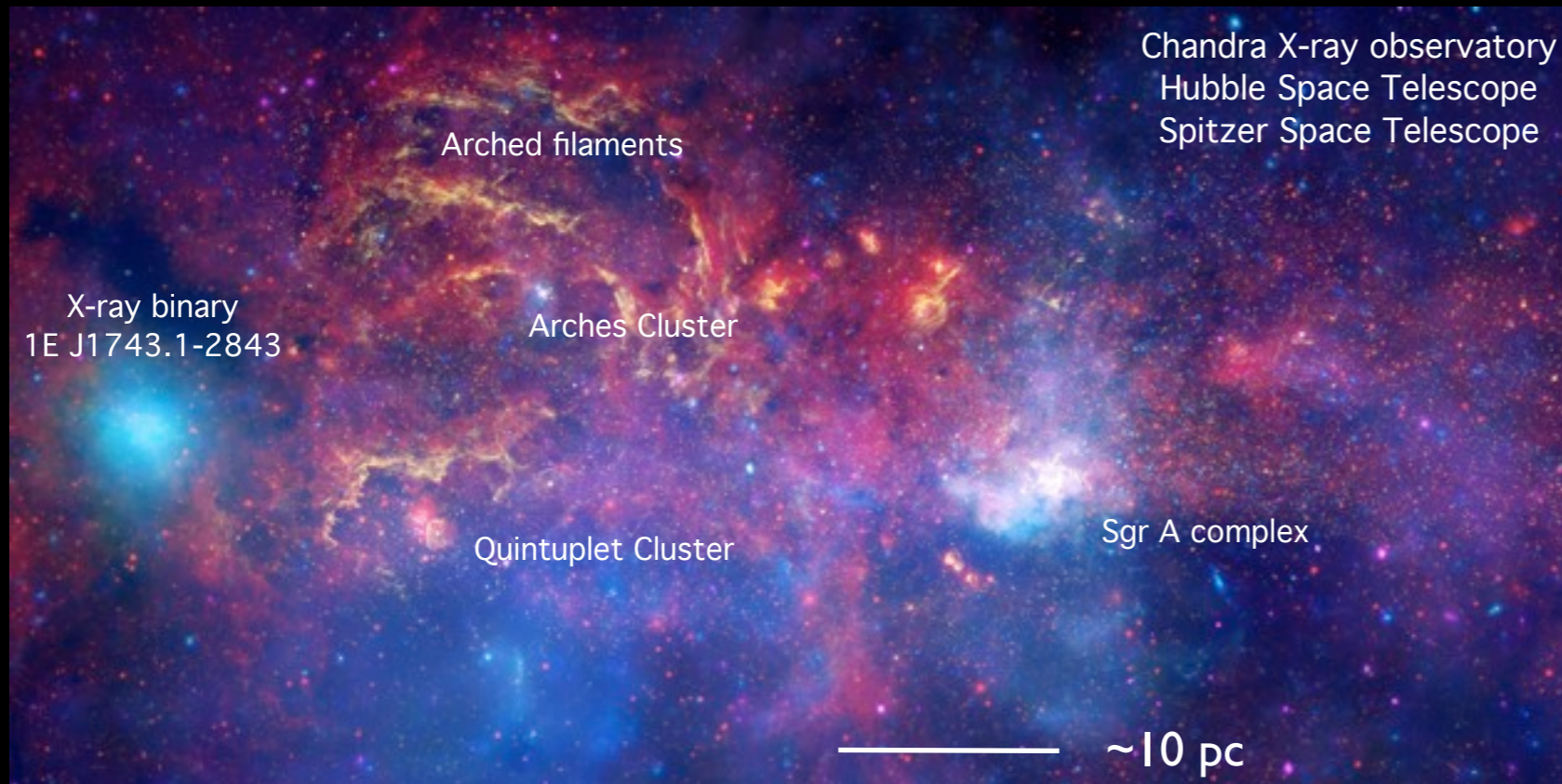
Renzo Capelli

Max Planck Institut für Extraterrestrische Physik, Garching (D)

with

*Peter Predehl, Stefan Gillessen, Bob Warwick, Nico Cappelluti*

# The Arches Cluster



Hubble - NICMOS  
Figer et al. 1999

$$M \gtrsim 10^4 M_{\odot} \quad R_{core} \approx 0.4 pc$$

$$\rho_{peak} \approx 3 \cdot 10^5 M_{\odot}/pc^3 \quad \tau = 2 - 2.5 Myr$$

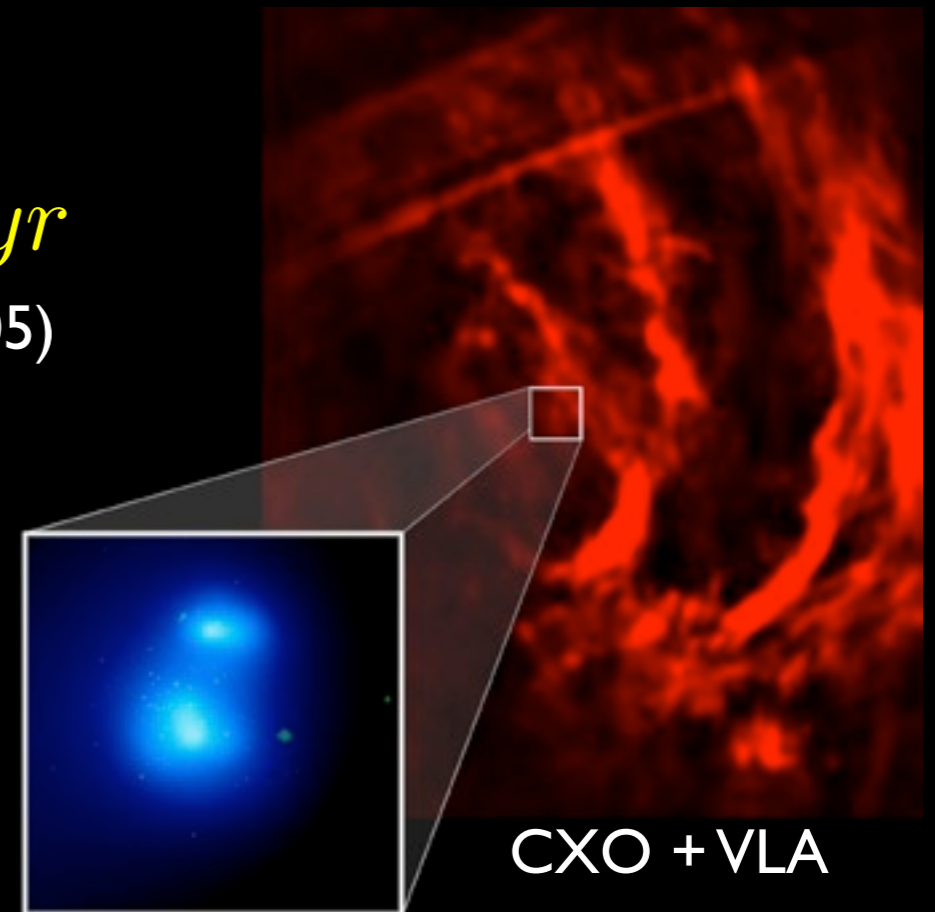
(Figer 2005)

X-ray profile  $\longrightarrow$  2 spots structure

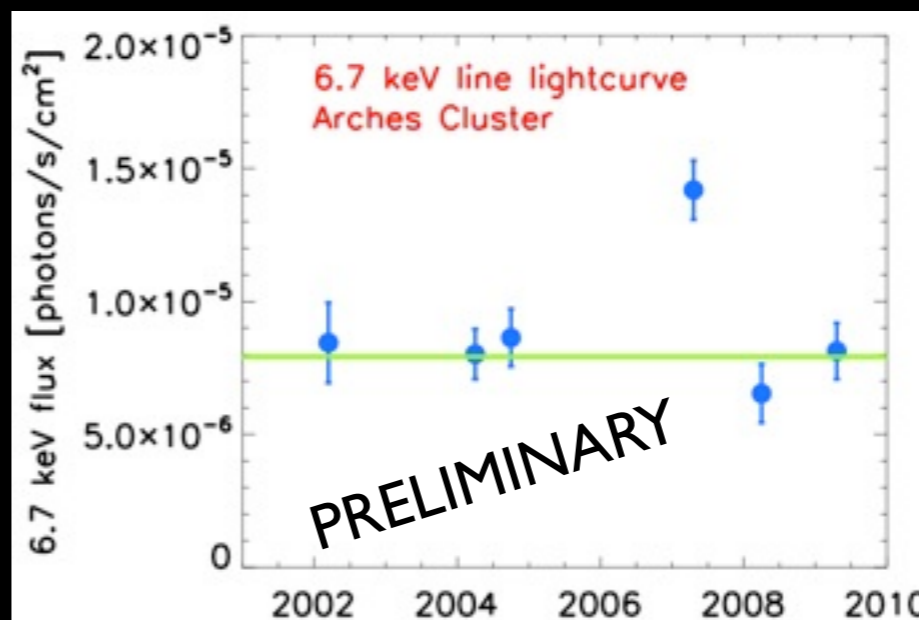
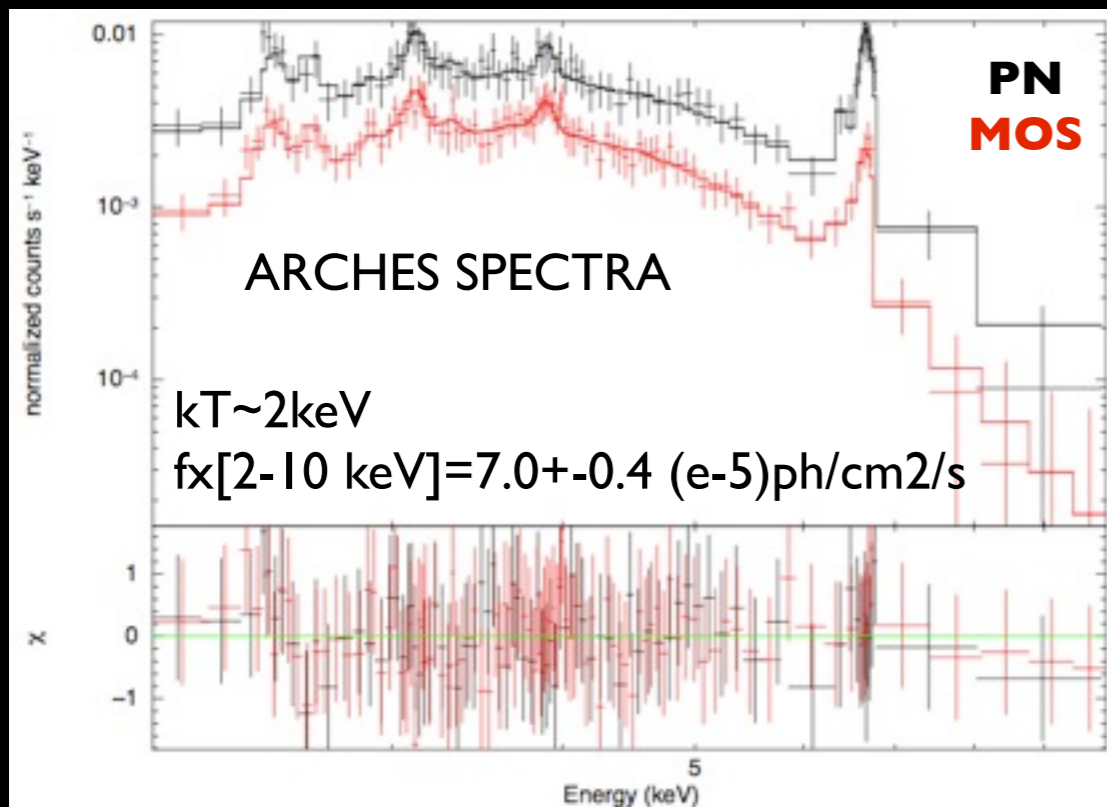
North: no radio emitting stellar sources

South: mass-losing stellar wind sources (up to  $10^{-4} M_{\odot}/yr$ ).

Radio from free-free emission in ionized winds.



# Colliding winds and X-ray variability within the AC

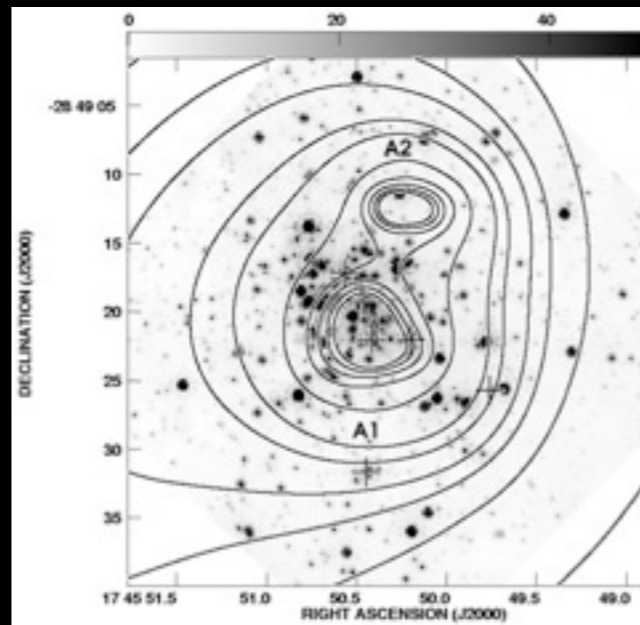
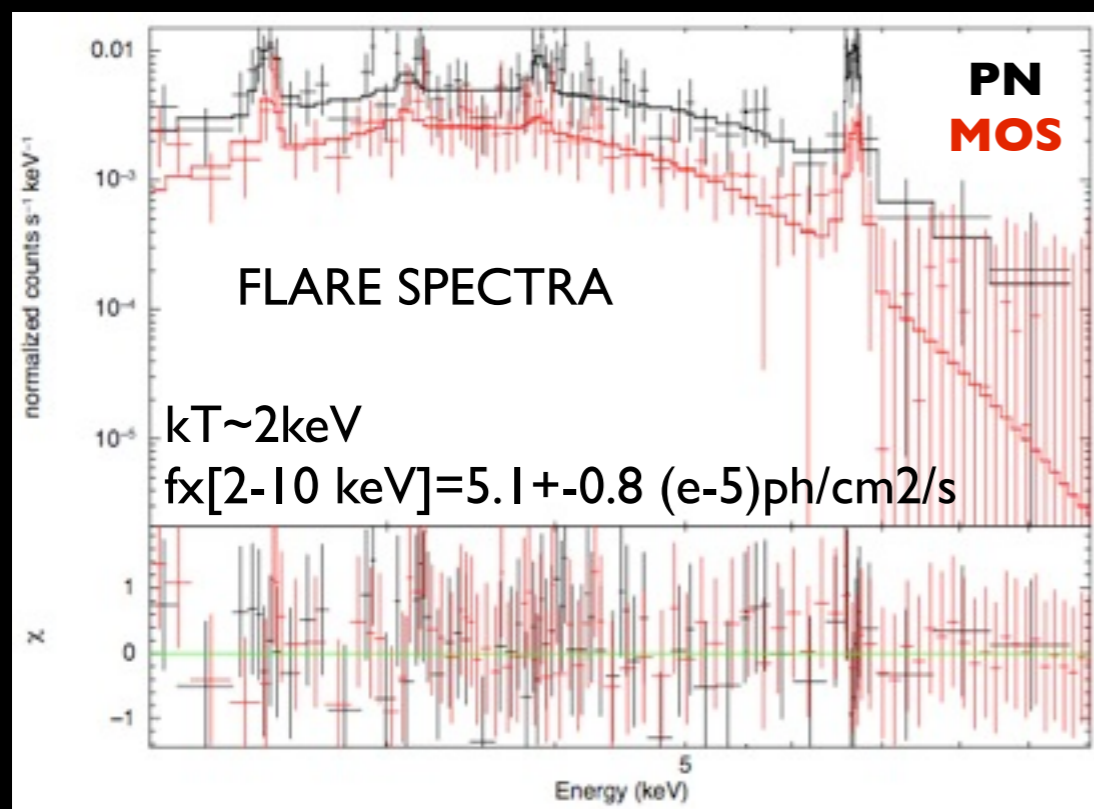


$\tau_{Flare} \gtrsim 4$  days

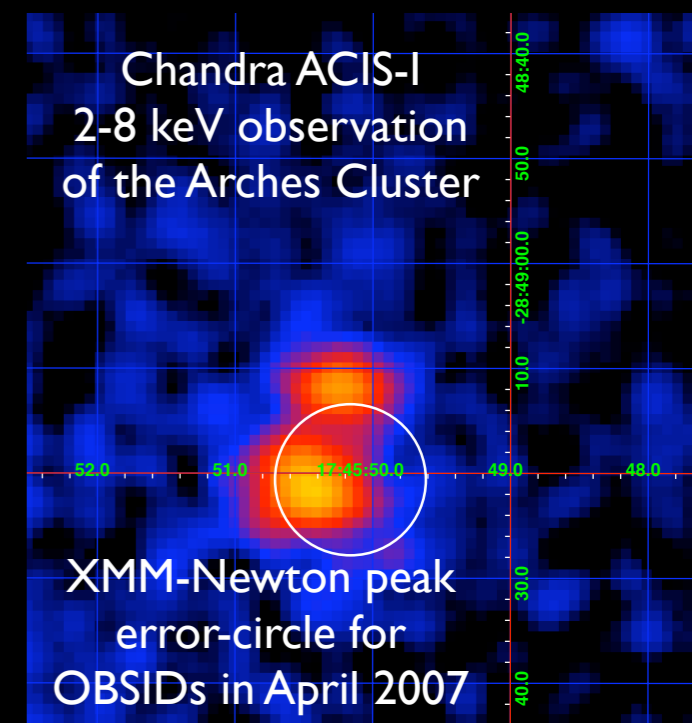
No substructure

$> 9\sigma$

Flare box coincident with strong radio sources in the southern component of the AC. + identify mass losing stellar wind sources (radio identification).



Yusef-Zadeh et al. 2002



Chandra ACIS-I  
2-8 keV observation  
of the Arches Cluster

XMM-Newton peak  
error-circle for  
OBSIDs in April 2007

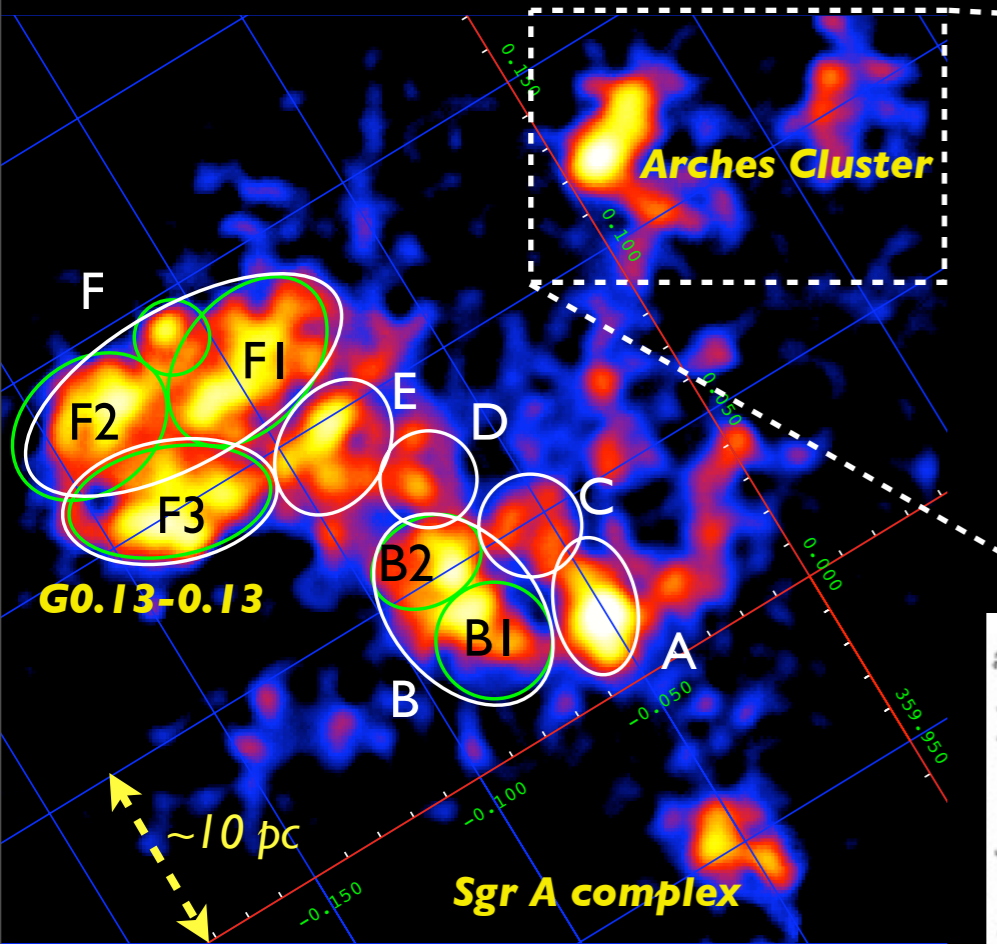
Shocks within colliding winds?  
Binary orbital modulation?

Capelli et al. 2010[b] A&A in prep.

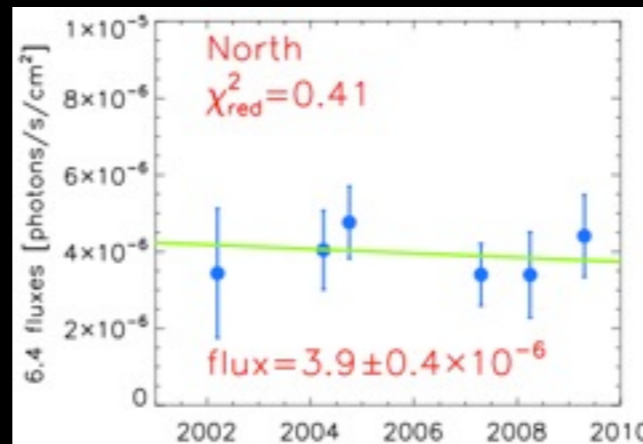
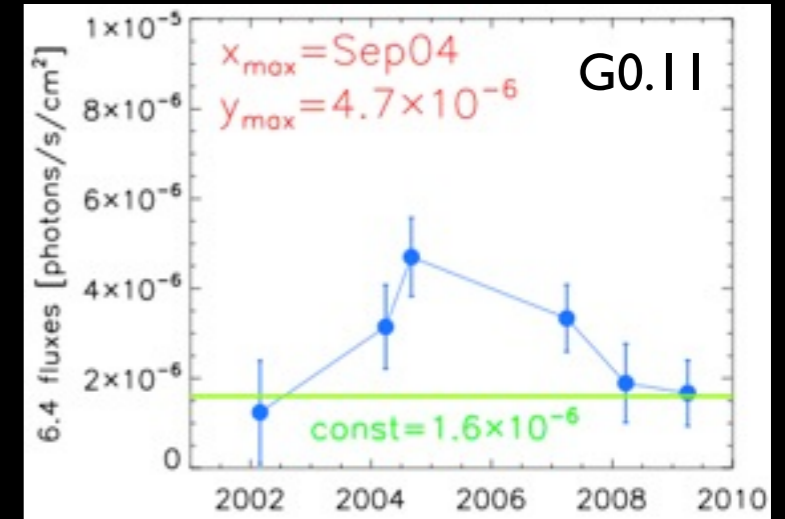
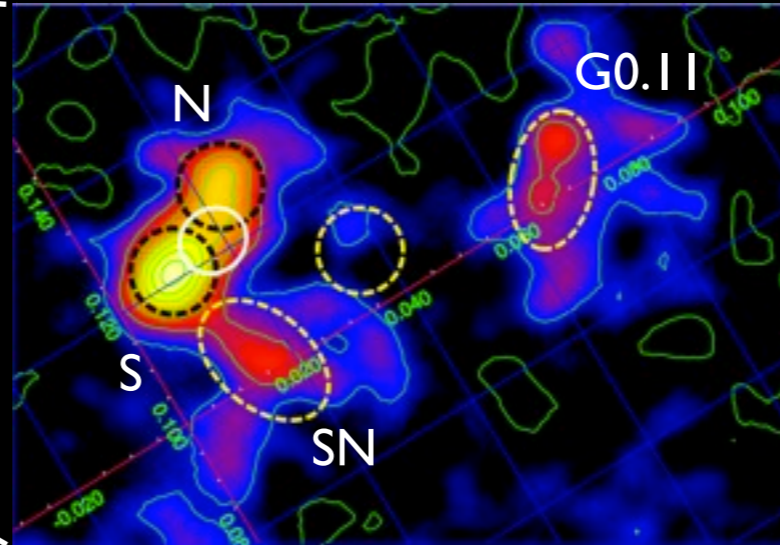
# 6.4 keV line: a big puzzle on diffuse X-rays from GC

**X-ray Reflection Nebulae:** Sgr A\* giant flare ~100 yr ago? ( $L_x \sim 10^{39}$  erg/s, Ponti et al. 2010)

**CRs bombardment:** LECRe and/or protons (Yusef-Zadeh et al. 2007 - Dogiel et al. 2009)



Capelli et al. 2010[a] A&A t.b.s.



XRN  
G0.11

Sgr A\*  
45 pc

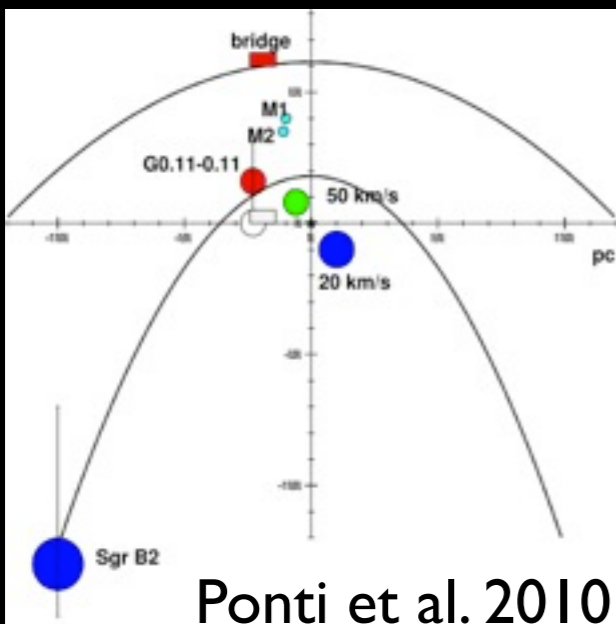
HMXB  
1.3 pc

LMXB  
13 pc

CRs  
G0.11

~20-30 eV/cm³

Capelli et al. 2010[b] A&A in prep.



Ponti et al. 2010

$$L_{x,2-10} = 6 \cdot 10^{38} \left( \frac{F_{6.4}}{10^{-4}} \right) \left( \frac{0.1}{\tau_T} \right) \left( \frac{\delta_{Fe}}{3 \cdot 10^{-5}} \right) \left( \frac{R}{100pc} \right)^2$$

Sunyaev & Churazov 1998

6.4 keV bright MCs in AC do **NOT** fit properly with XRN model.  
**G0.11+0.07** measured to be the **fastest** XRN in the GC.

Source: HMXB/SNR?

# Summary

First detection of X-ray variability within the Arches Cluster likely connected with early-type O-WR stars.

XMM monitored 6.4 keV bright Molecular Clouds in the GC region: XRN model alone has some difficulties in interpreting all the features.

We report the detection of a fast 6.4 keV variability in G0.11+0.07: unique rise/fall monitoring - XRN

Molecular Clouds in the Arches Cluster surroundings: an ongoing particle bombardment. CRs likely accelerated in situ.

Impact of young, massive, compact clusters on the High Energy activity of the GC region