Stellar birth and death in a spiral galaxy

International Centre for Radio Astronomy Research

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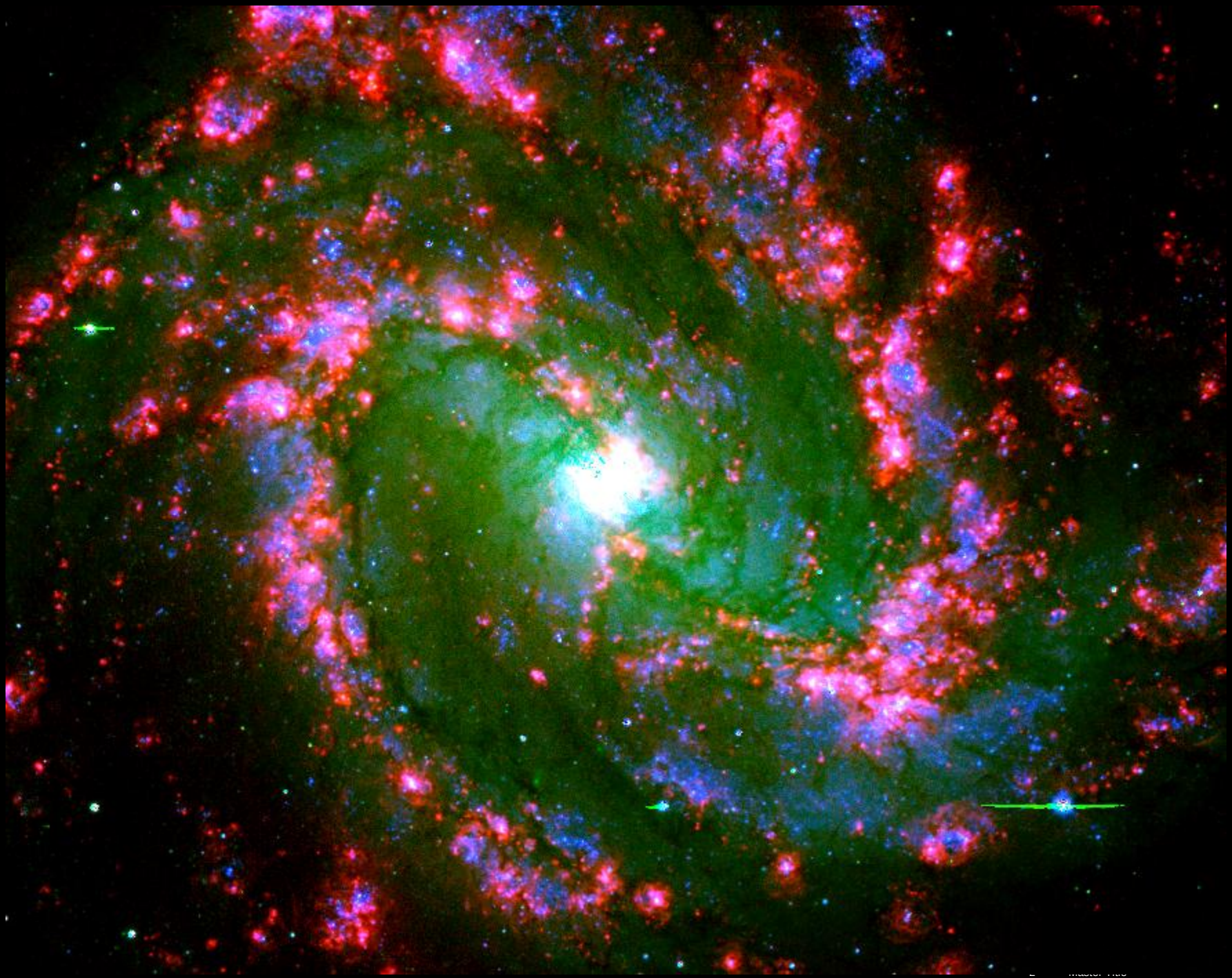
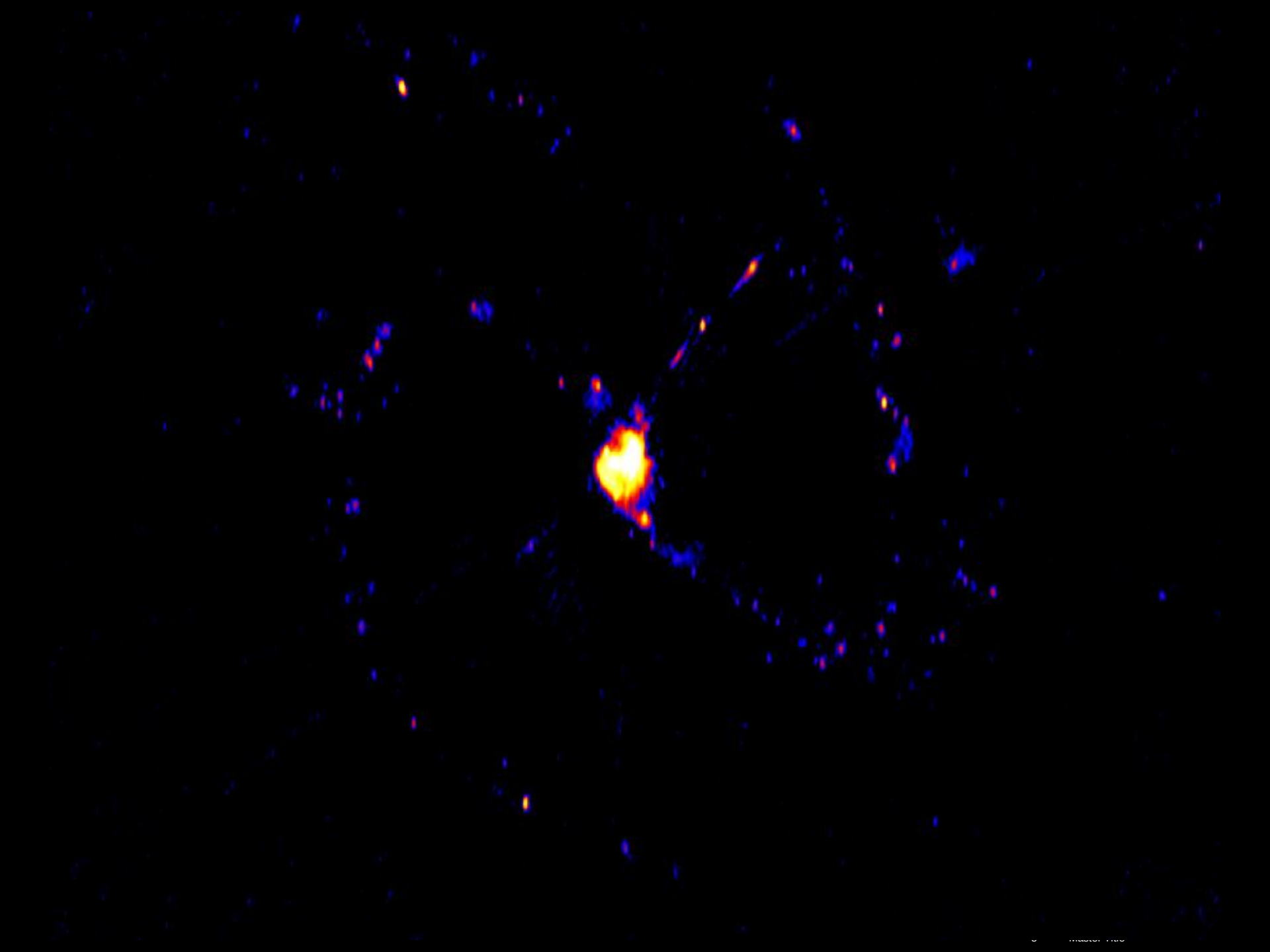


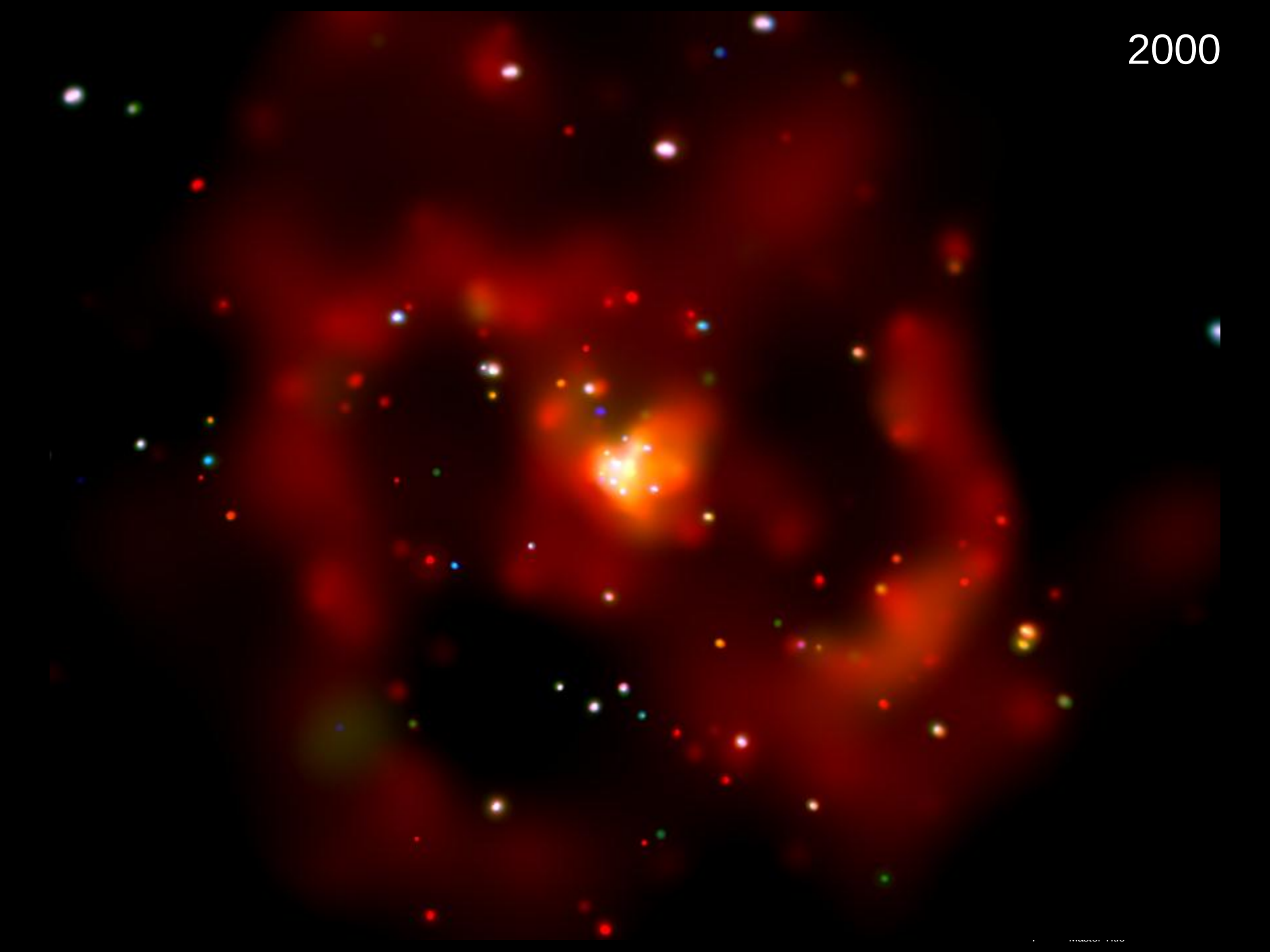


Our multiband campaign for M83

X-ray
Chandra Large Project (730 ks)
Swift monitoring

Optical:
HST narrow- and broad-band (~ 50 orbits)
Magellan
Gemini

Radio:
Australia Telescope Compact Array (ATCA)
eVLA
Australia's Long Baseline Array


2000


2010-11

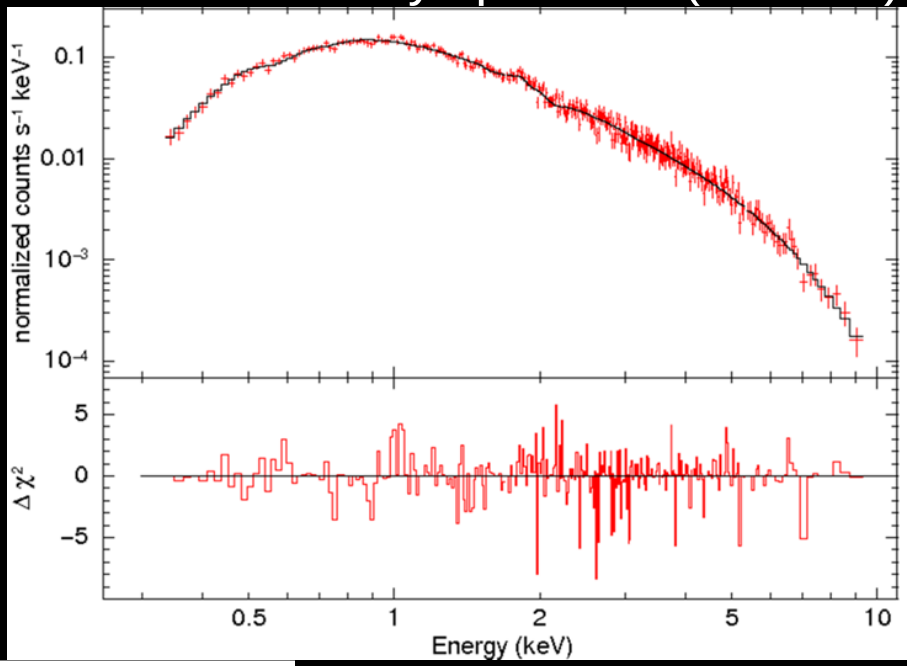
New Ultraluminous X-ray source

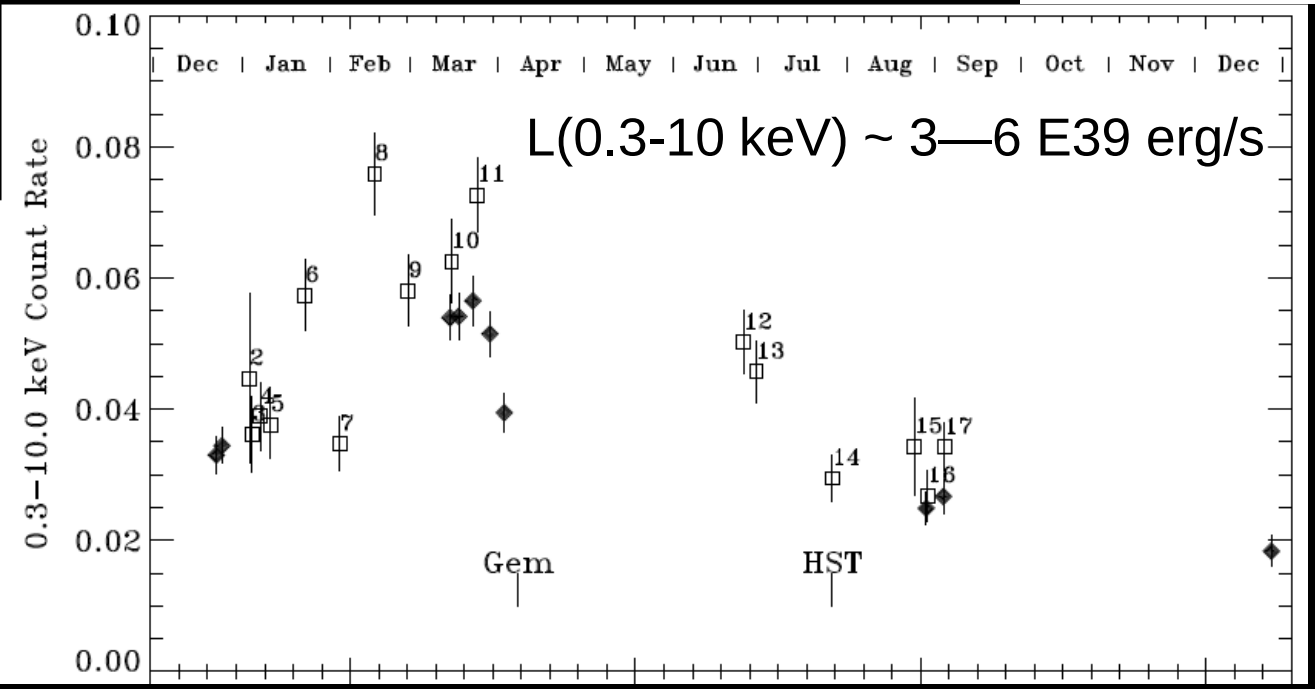
(brightest X-ray source in M83)

Outburst started sometime
between 2010 Apr and 2010 Dec

Chandra/Swift monitoring

Featureless X-ray spectrum (no lines)

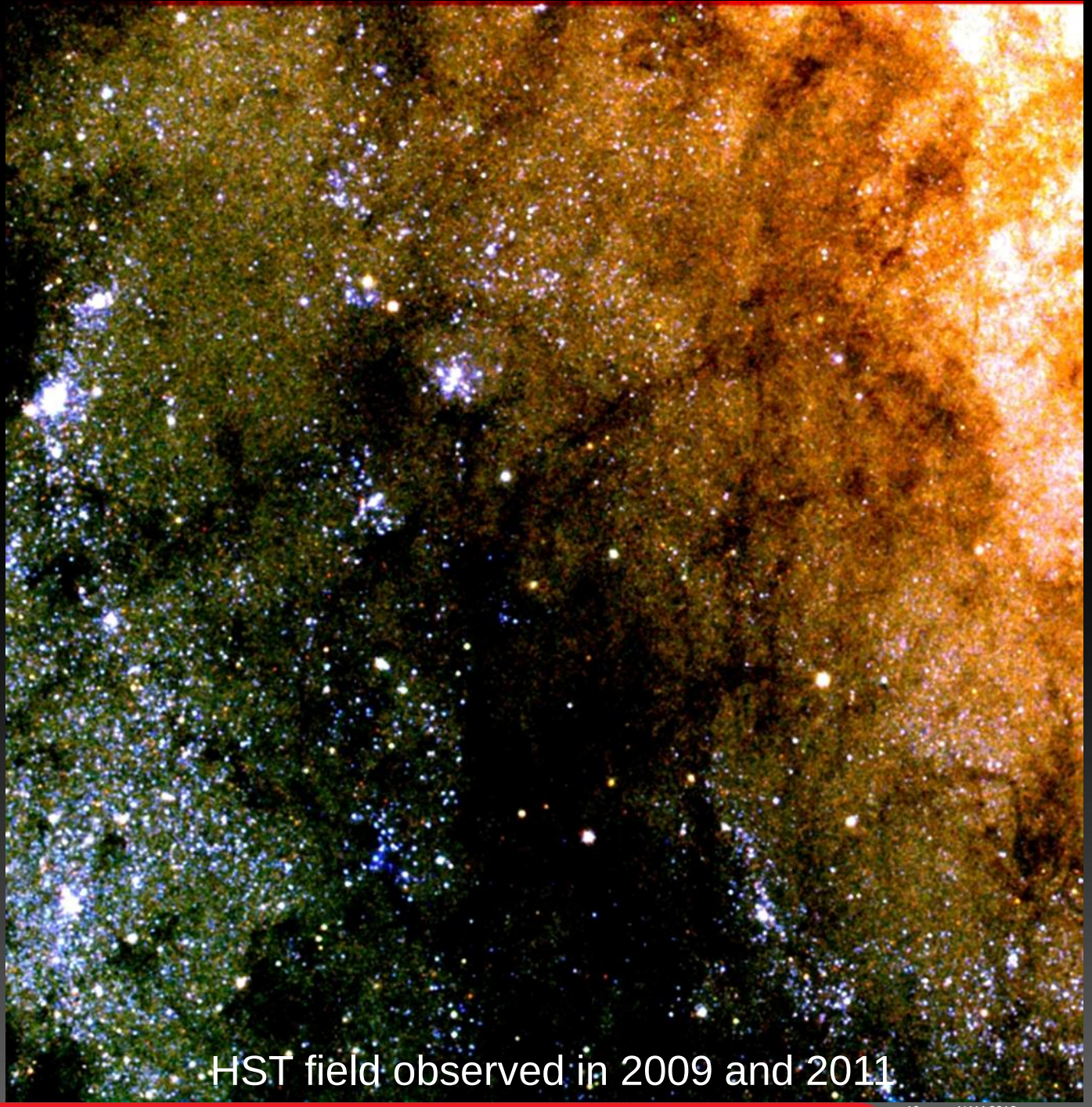




Typical ULX spectrum:
(dominant) power-law +
soft diskbb component

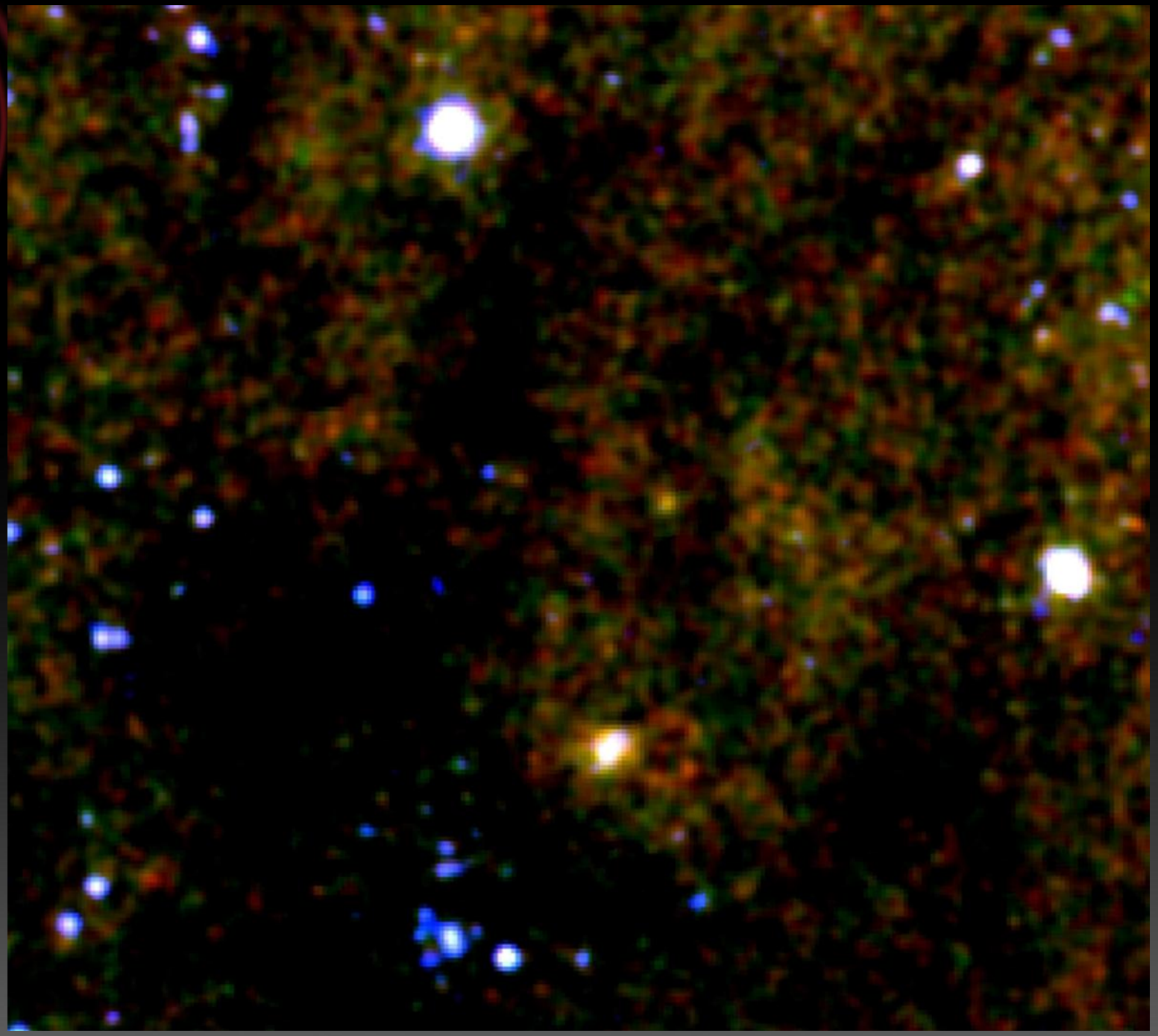
T(dbb) <~ 0.4 keV

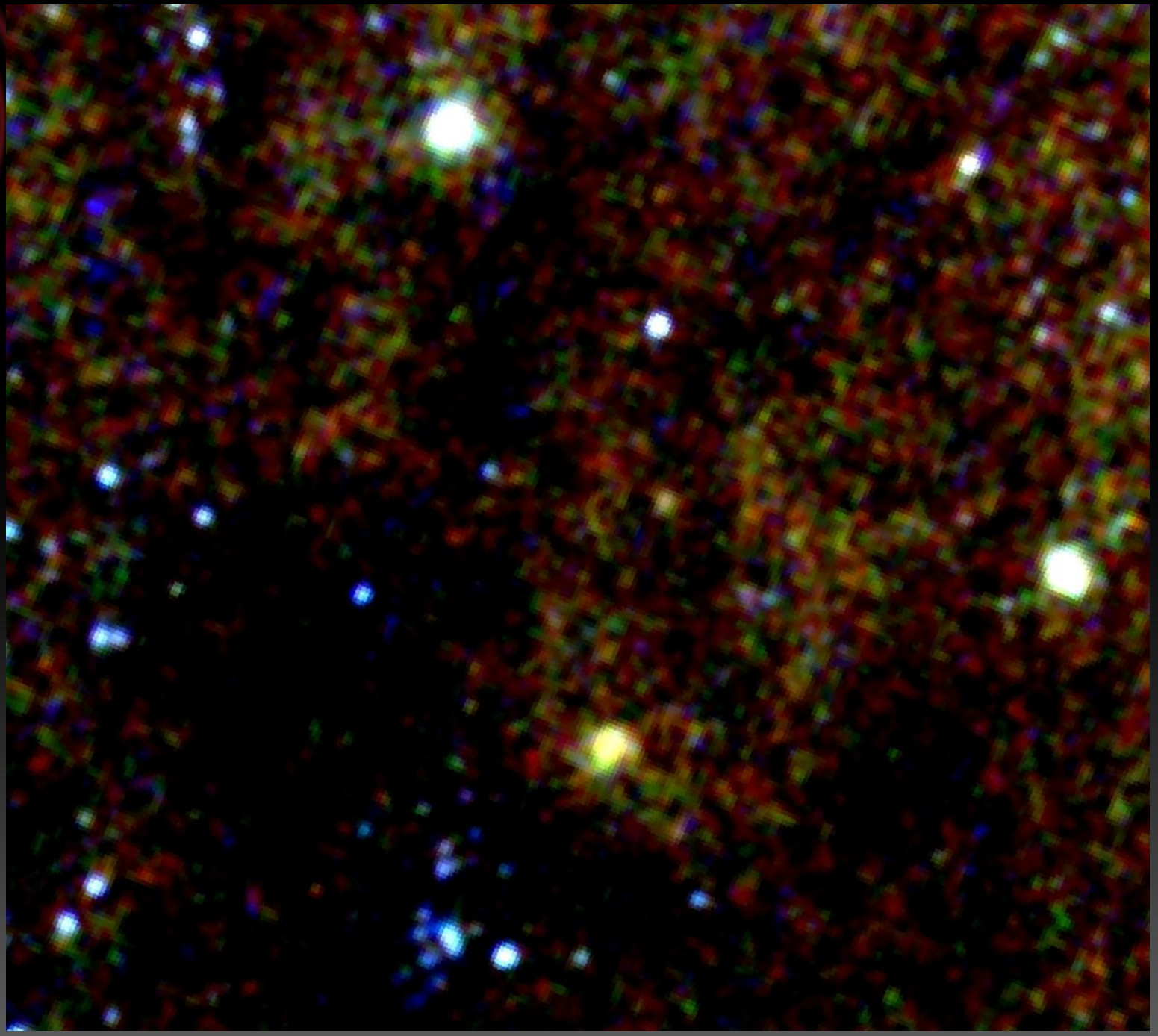
Spectral evolution:
softer when brighter



HST field observed in 2009 and 2011

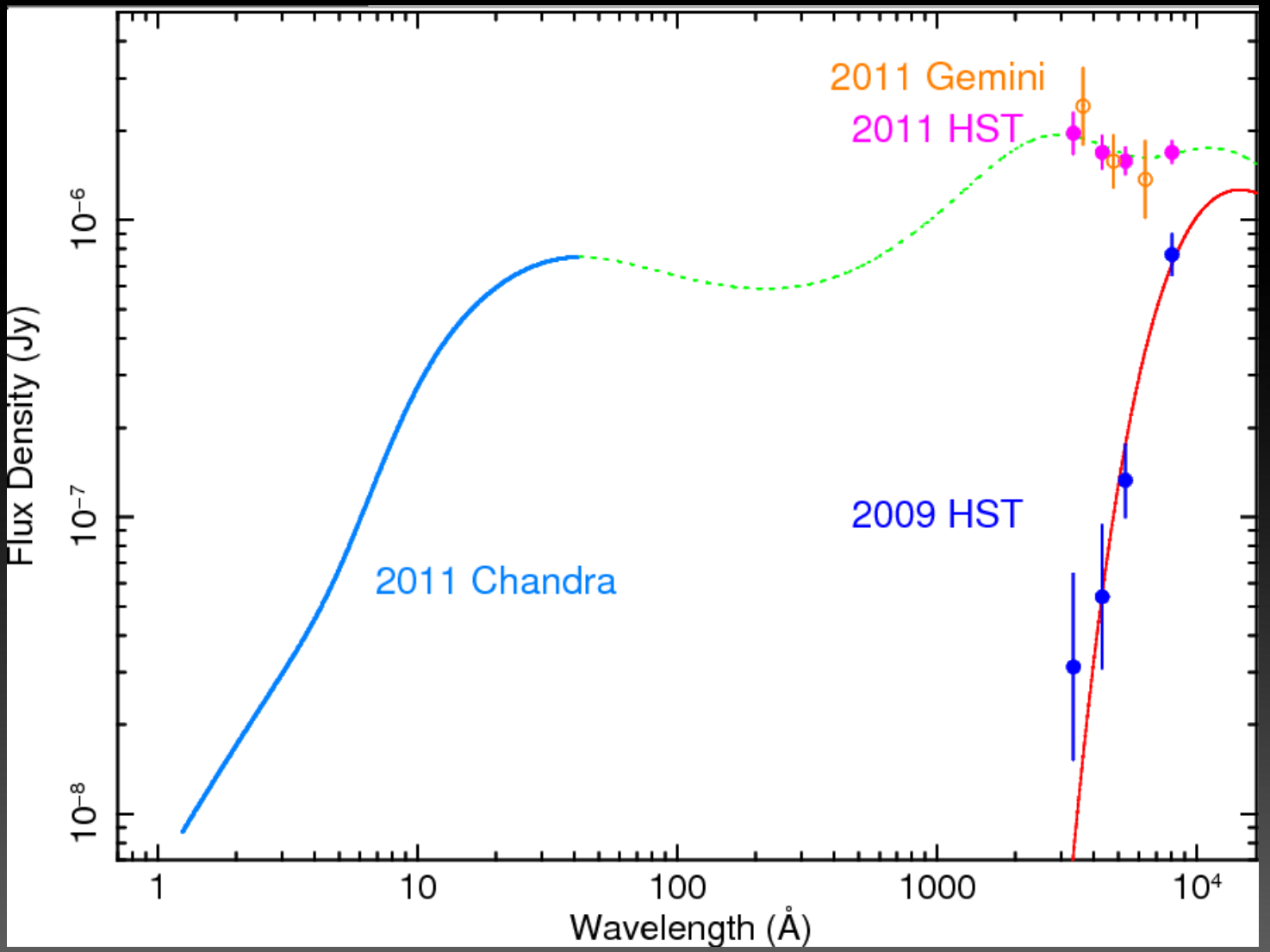
HST field observed in 2009 and 2011



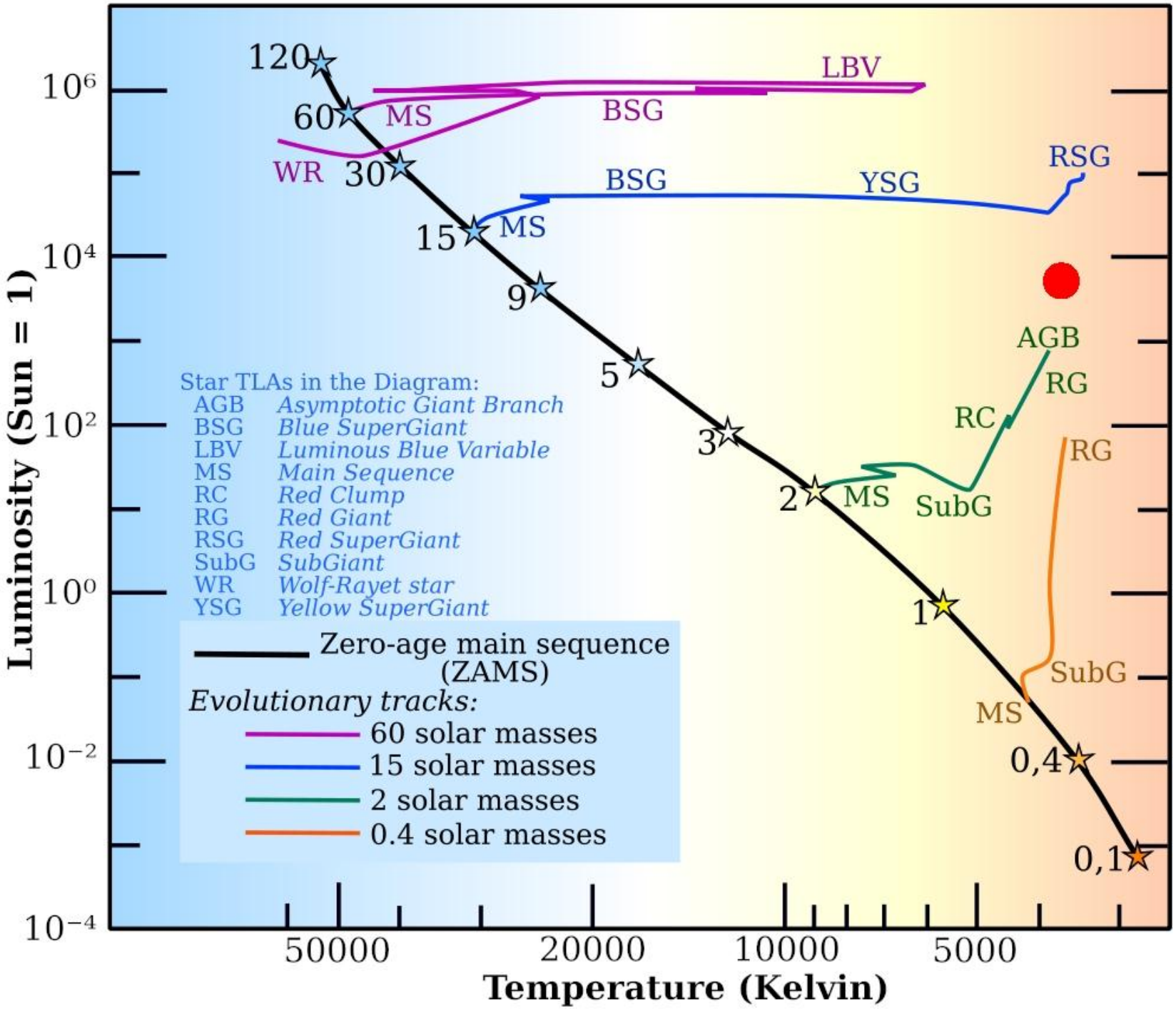


Optical emission in *outburst*: irradiated disk (T >~ 20,000 K)

Optical emission in *quiescence*: low-mass AGB star (T ~ 3400 K)



Soria et al 2012,
ApJ, in press


120
60
30
15
9
5
3
2
1
0,4
0,1
LBV
BSG
MS
WR
BSG
YSG
RSG
MS
AGB
RG
RC
RG
MS
SubG
SubG
MS
Star TLAs in the Diagram:
AGB Asymptotic Giant Branch
BSG Blue SuperGiant
LBV Luminous Blue Variable
MS Main Sequence
RC Red Clump
RG Red Giant
RSG Red SuperGiant
SubG SubGiant
WR Wolf-Rayet star
YSG Yellow SuperGiant
Zero-age main sequence (ZAMS)
Evolutionary tracks:
60 solar masses
15 solar masses
2 solar masses
0.4 solar masses
Luminosity (Sun = 1)
10⁶
10⁴
10²
10⁰
10⁻²
10⁻⁴
50000
20000
10000
5000
Temperature (Kelvin)

Summary of our ULX study

We discovered a transient ULX
with old, low-mass donor

(see also the transient ULX in M31, Middleton et al 2012)

Analogy with Galactic BHs

"LMXB" ULXs (old, low-mass donors) *Transient?*

vs

"HMXB" ULXs (OB donor) *Persistent?*

Large population of heavy stellar BHs in the off state?

We see the optical emission from the accretion disk

→ opportunities for optical spectroscopy, to get BH mass function

Other work in progress

X-ray binary populations (~ 500 XRBs, as many as known in the MW)

X-ray properties vs age/metallicity of young star clusters

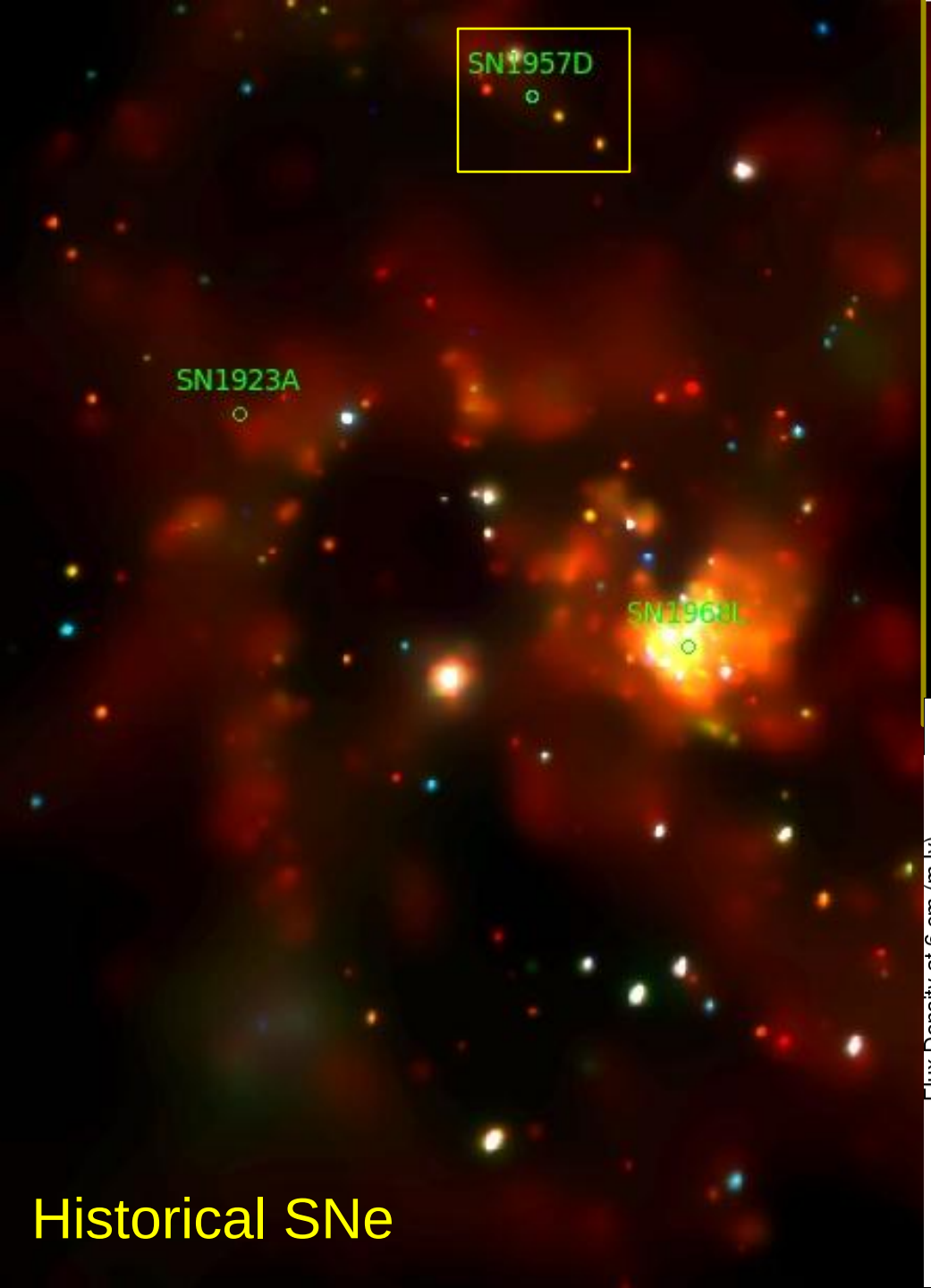
Diffuse hot gas (why is it so well confined in the arms?)

Young supernova remnants (~ 200 candidates between radio/opt/X)

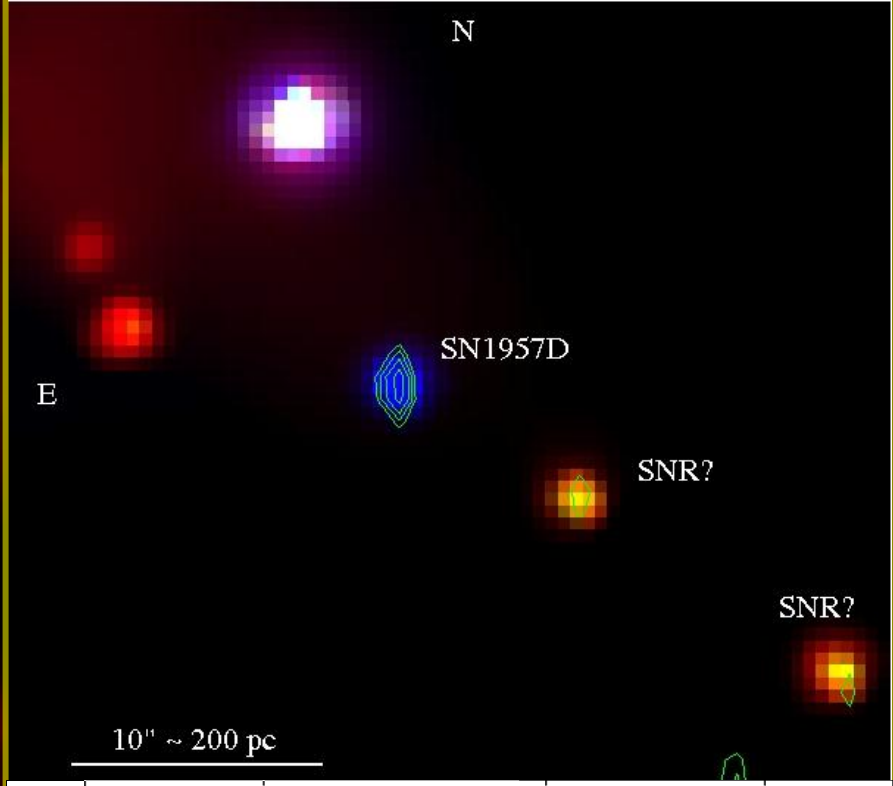
Historical SNe (6 over the last 100 years)

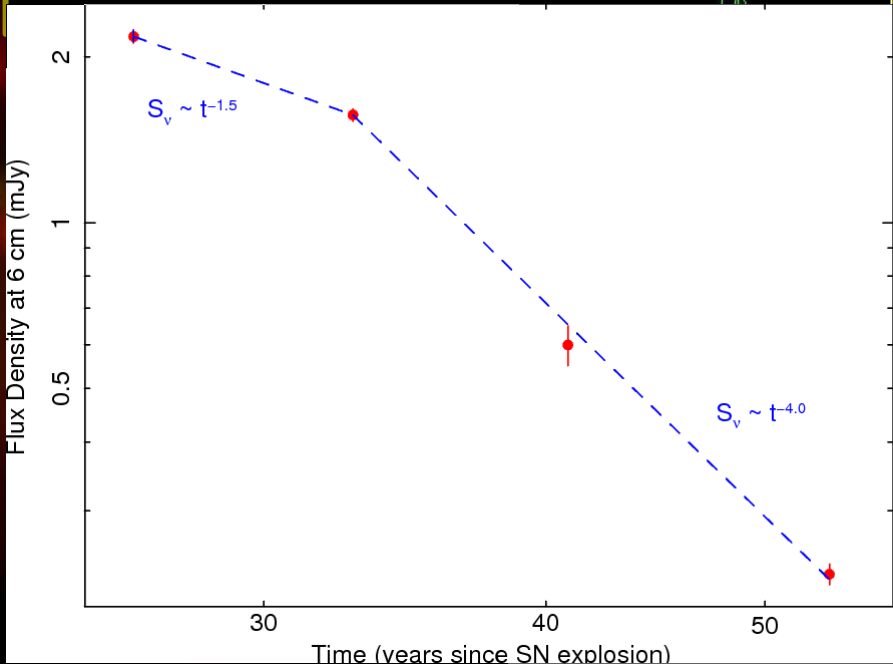
Future SNe (*HST* survey deep enough to resolve most OB stars)

Starburst and accretion around nuclear BH(s?)

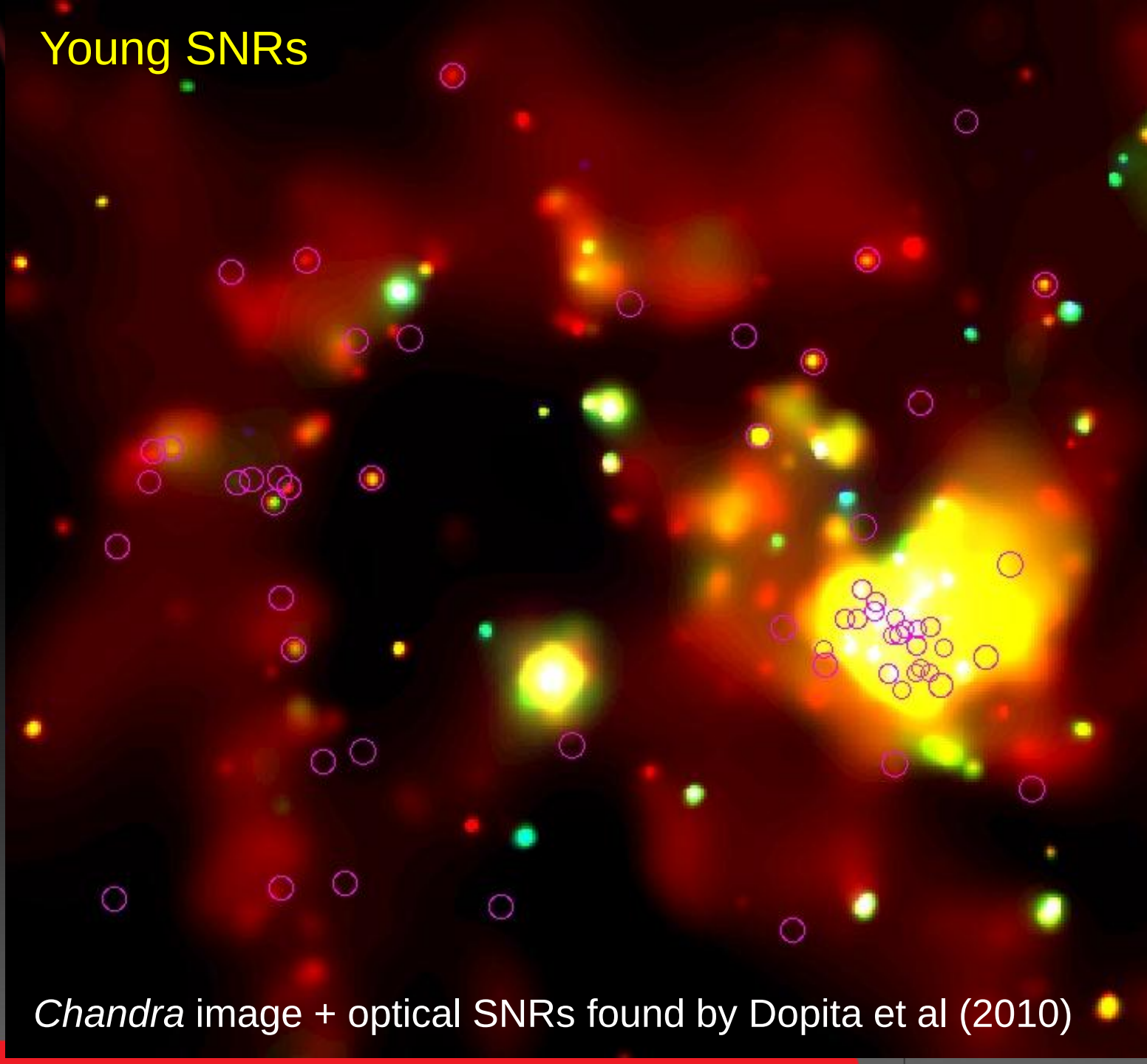


Historical SNe

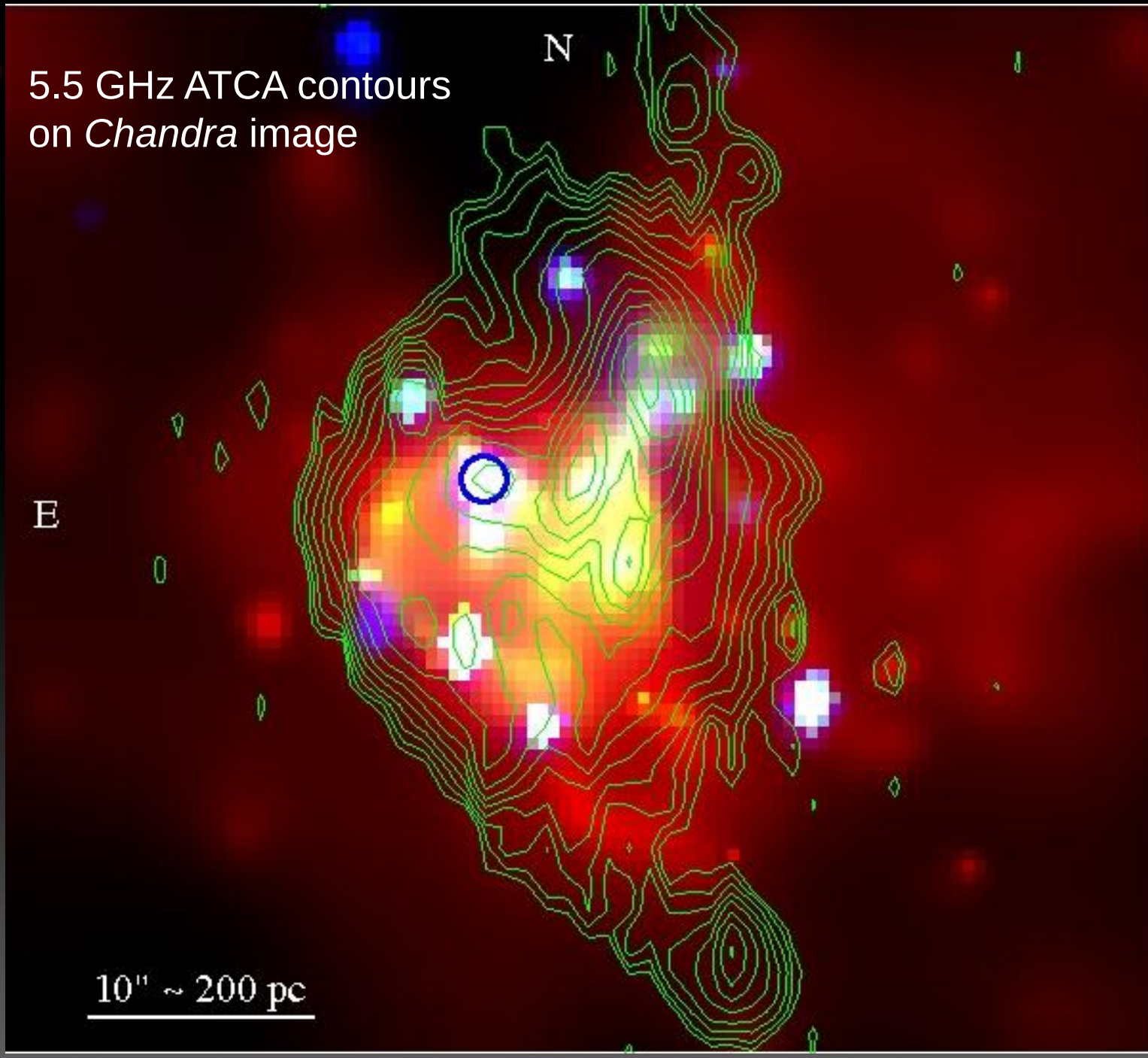




Young SNRs



Chandra image + optical SNRs found by Dopita et al (2010)


5.5 GHz ATCA contours
on *Chandra* image
N
E
10" ~ 200 pc

Conclusions

Deepest X-ray & multiband study of a face-on spiral galaxy

Together with deep studies of M31, M33, M81, M101
will provide new understanding of
star formation → SNe, SNRs → hot gas, compact remnants
in different environments (arms, bar, nuclear rings) and metallicity

First results:
transient ULX, SN1957D, many new SNRs, 500 X-ray binaries