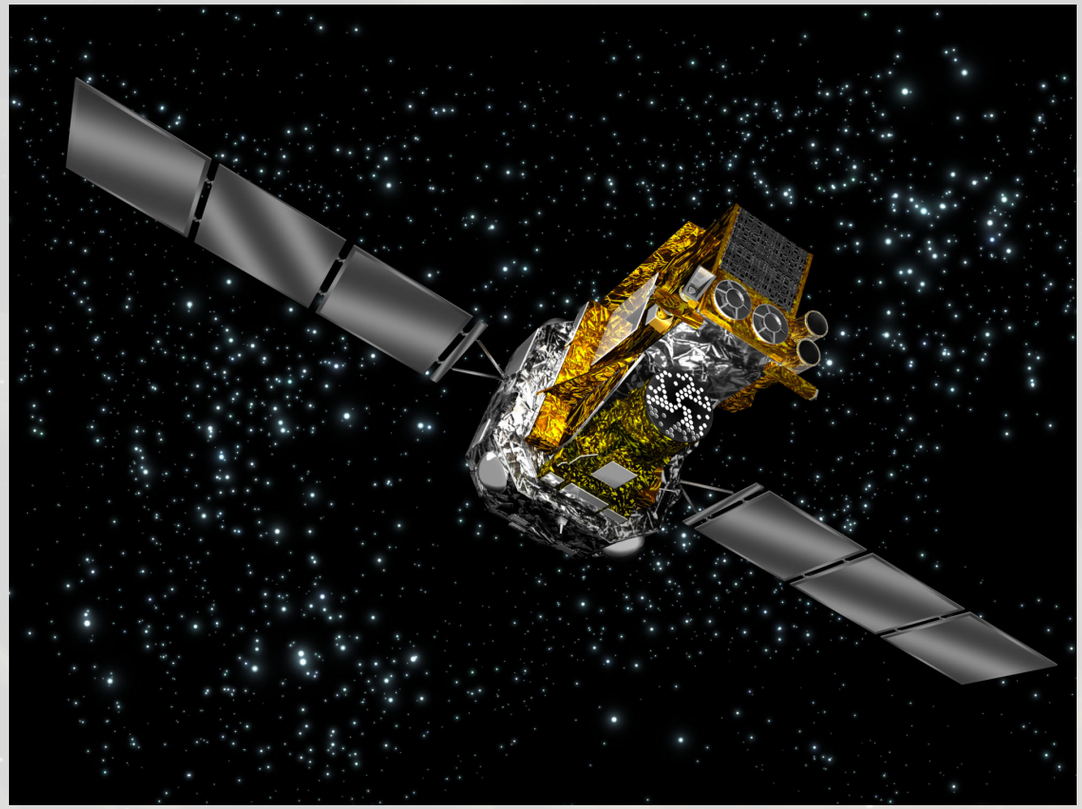

Dr. Karl Remeis Sternwarte/ECAP:
X-ray Gang and Multi Wavelength Group
J. Wilms & Manami Sasaki

*XMM-Newton* (ESA): launched 10 Dec. 1999



*INTEGRAL* (ESA): launched 17 Oct. 2002

Currently active missions: X-ray Multiple-Mirror Mission (*XMM-Newton*; ESA), International Gamma-Ray Laboratory (*INTEGRAL*; ESA), *Spectrum-X-Gamma* (RU, D), *Chandra* (USA), *ASTROSAT* (India), *Swift* (USA), Fermi (USA), *AGILE* (Italy), *NuSTAR (USA)*, *NICER* (USA), *HXMT (China)*, *DAMPE* (China)

In addition many studies/planned missions: *ATHENA* (ESA), *XRISM* (Japan, USA), *eXTP* (China, Europe), *ARCUS* (NASA).

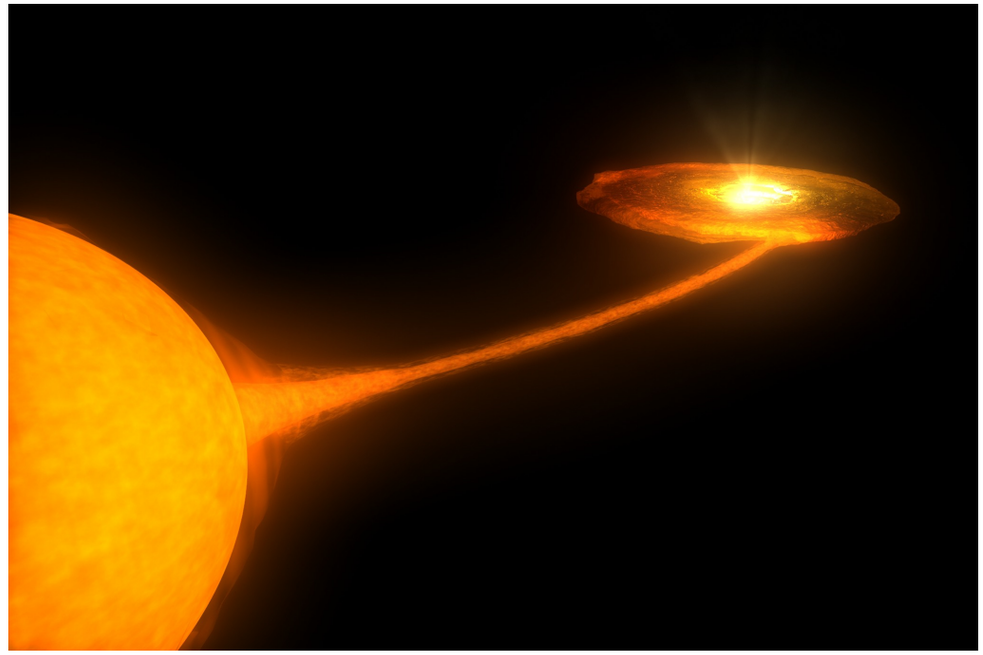
Our large advantage: experience with most current high energy missions, participation in many future missions.


. . . and coordinated multiwavelength observations (close collaboration with Würzburg – see tomorrow);
plus participation neutrino-obs

# Black Holes

Active Galactic Nuclei

$M_{\mathrm{BH}} \sim 10^{6...10}\, M_\odot$, $L \lesssim 10^{9...14}\, L_\odot$



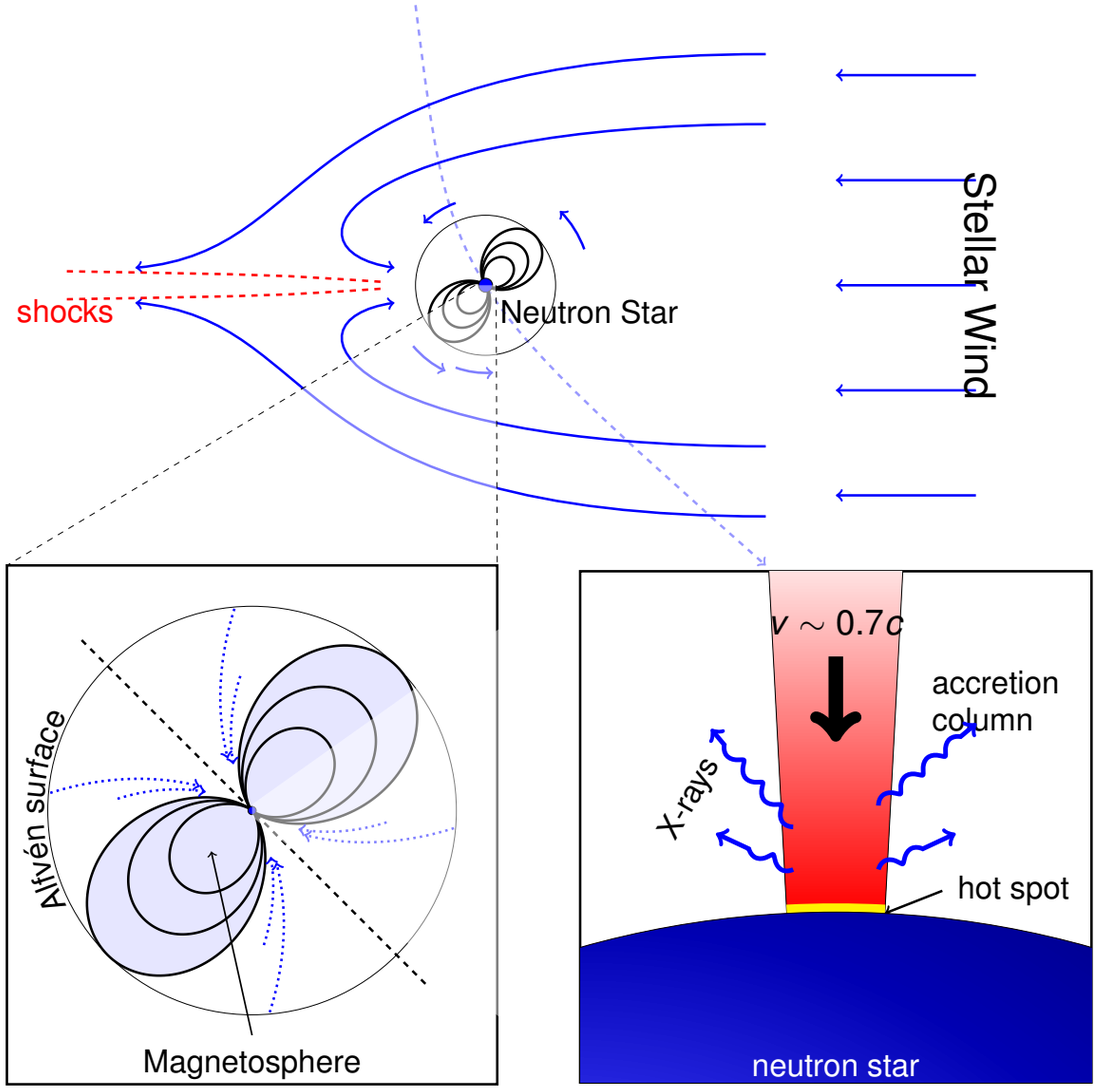
Galactic Black Holes

$M_{\mathrm{BH}} \sim 10\, M_\odot$, $L \lesssim 10^{5}\, L_\odot$

Active Galaxies, galactic Black Holes – relativistic reflection modeling, variability, stellar winds, outflows and jets

close collaboration with M. Kadler (Uni. Würzburg), K. Pottschmidt (GSFC), M.A. Nowak (WUSTL), C.S. Reynolds (Cambridge), R. Ohja (GSFC), V. Grinberg (Tübingen), N. Schartel (ESAC), S. Markoff (Amsterdam), J. Rodriguez (CEA Saclay), J. Lee (Harvard), J. Tomsick (Berkeley),. . .

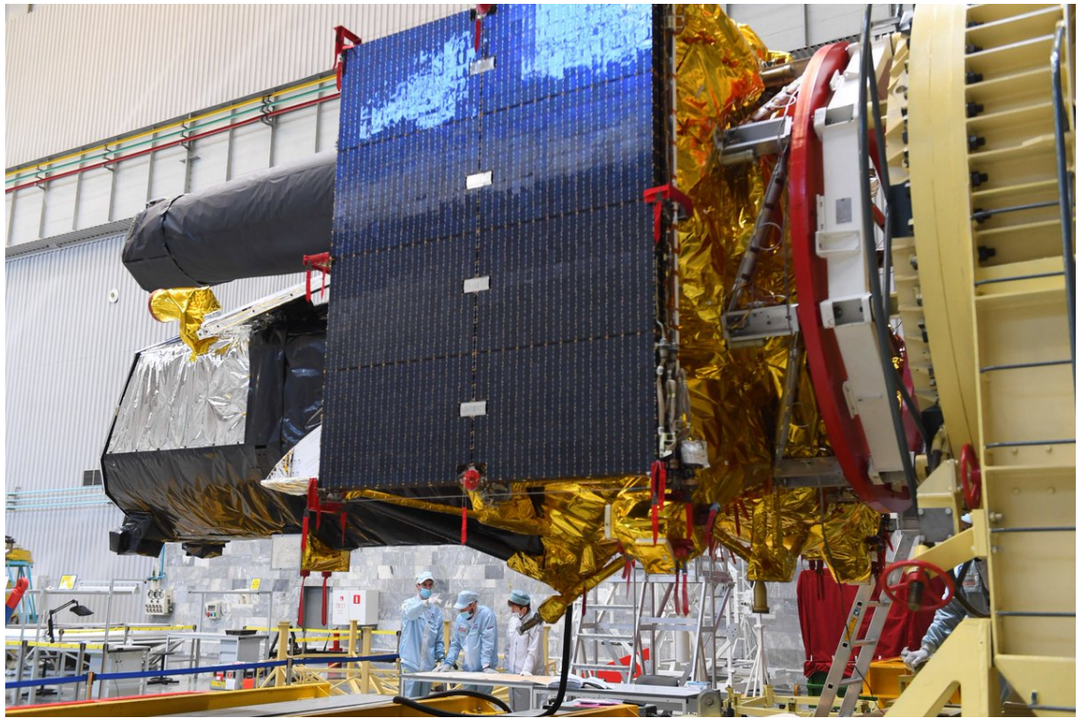
# Neutron Stars




strongly magnetized neutron stars ($10^8$ T), formation of cyclotron lines, Be outbursts

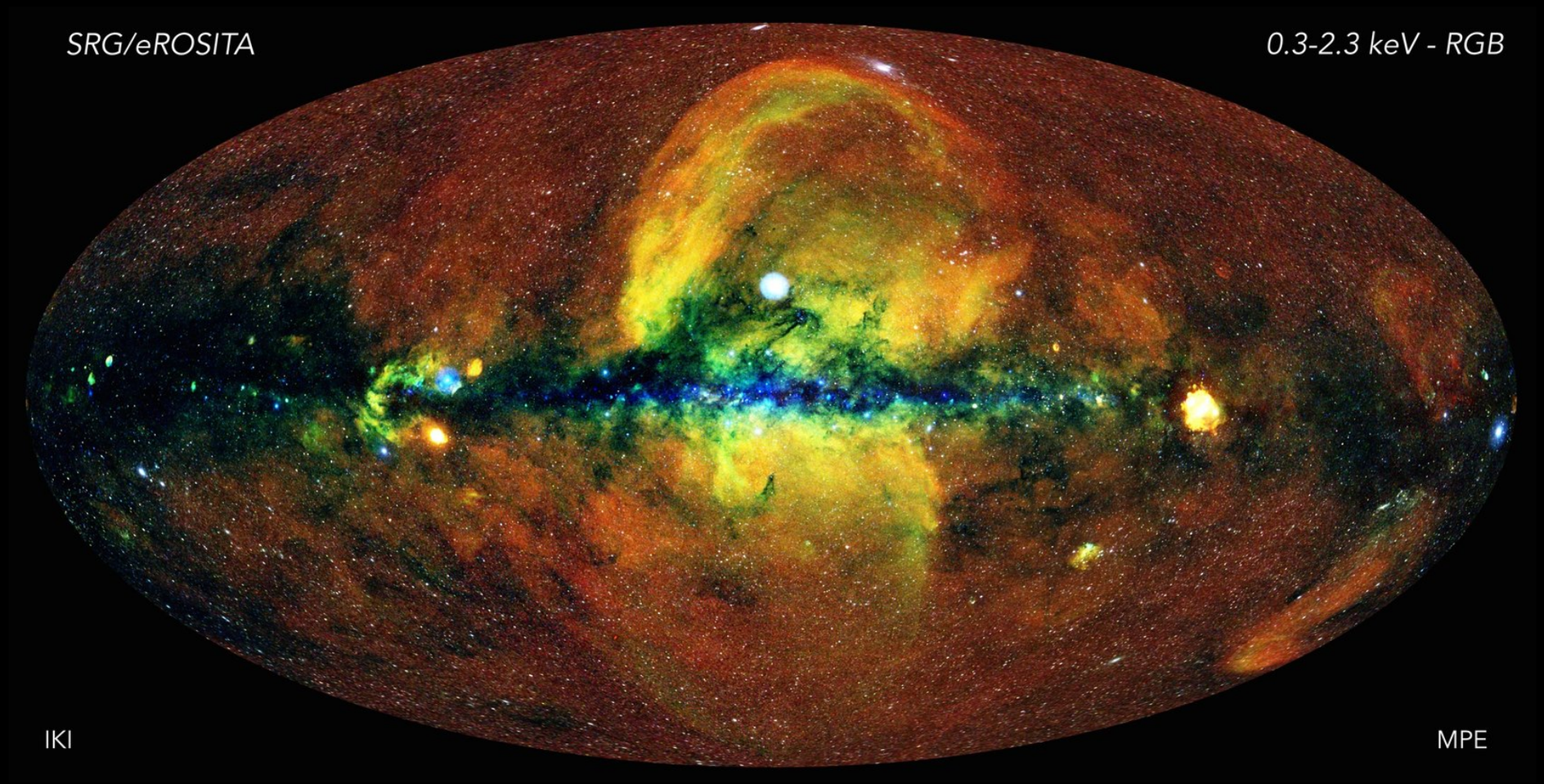
Collaboration with K. Pottschmidt (GSFC), R. Rothschild (UCSD), P. Kretschmar (ESAC), K. Postnov (Moscow), M. Wolff (NRL), R. Staubert (Tübingen), A. Santangelo (Tübingen), A. Bodaghee (Atlanta), J. Torrejón (Alicante), P.A. Becker (GMU), C. Ferrigno (ISDC Geneva)

# Projects

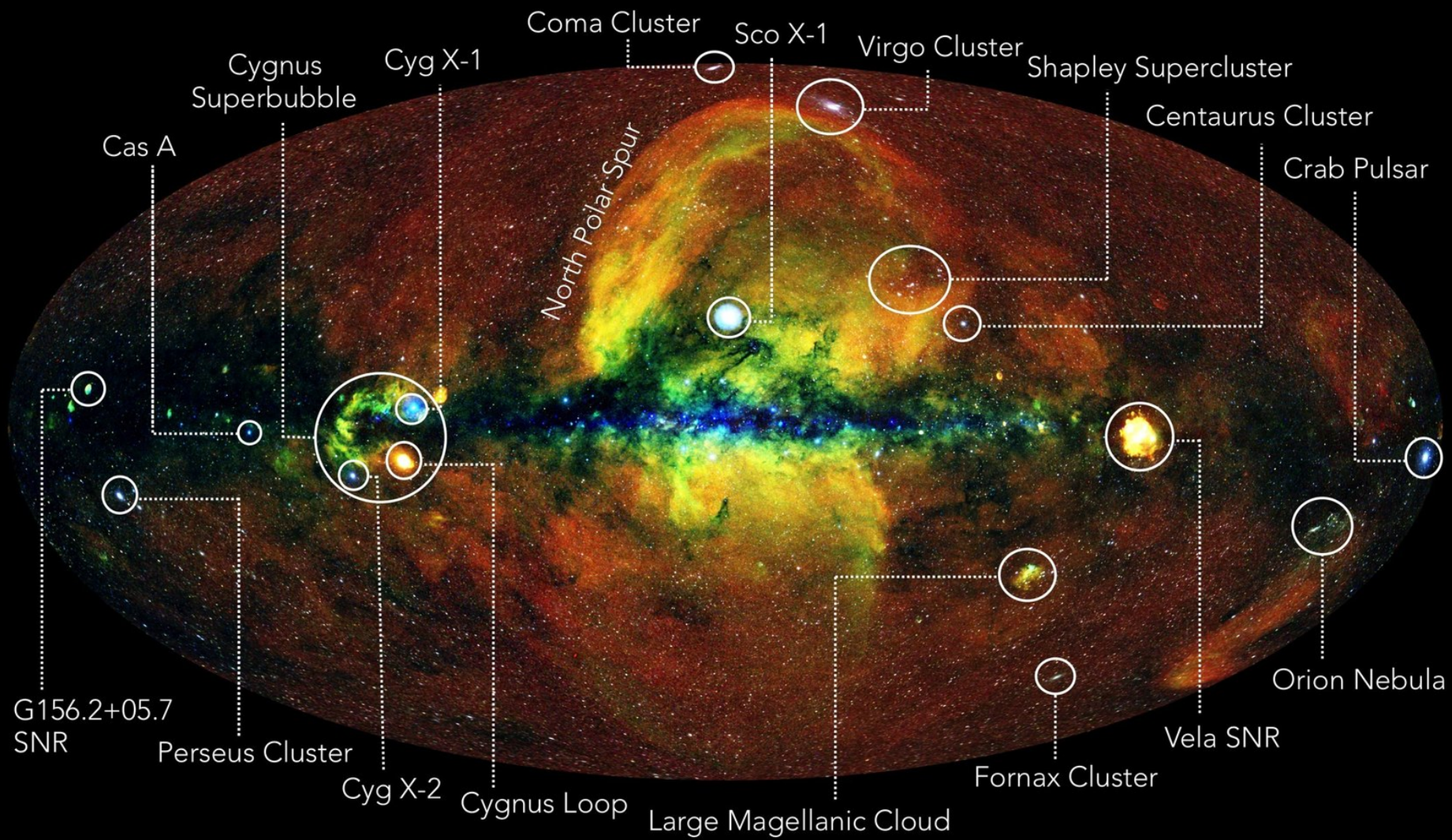


13.07.2019: Launch of Spectrum-X-Γ: eROSITA

# The 1st eROSITA Survey

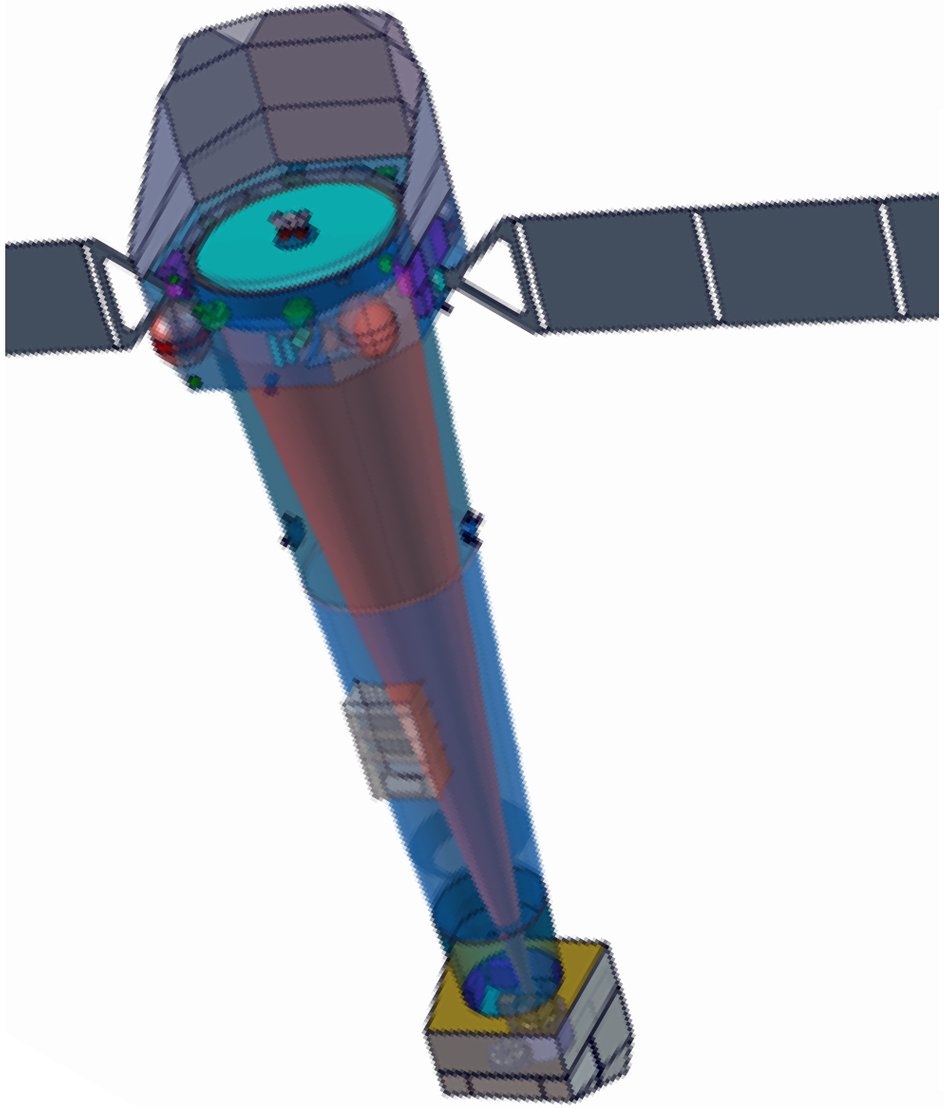


# Navigating the eROSITA X-ray sky

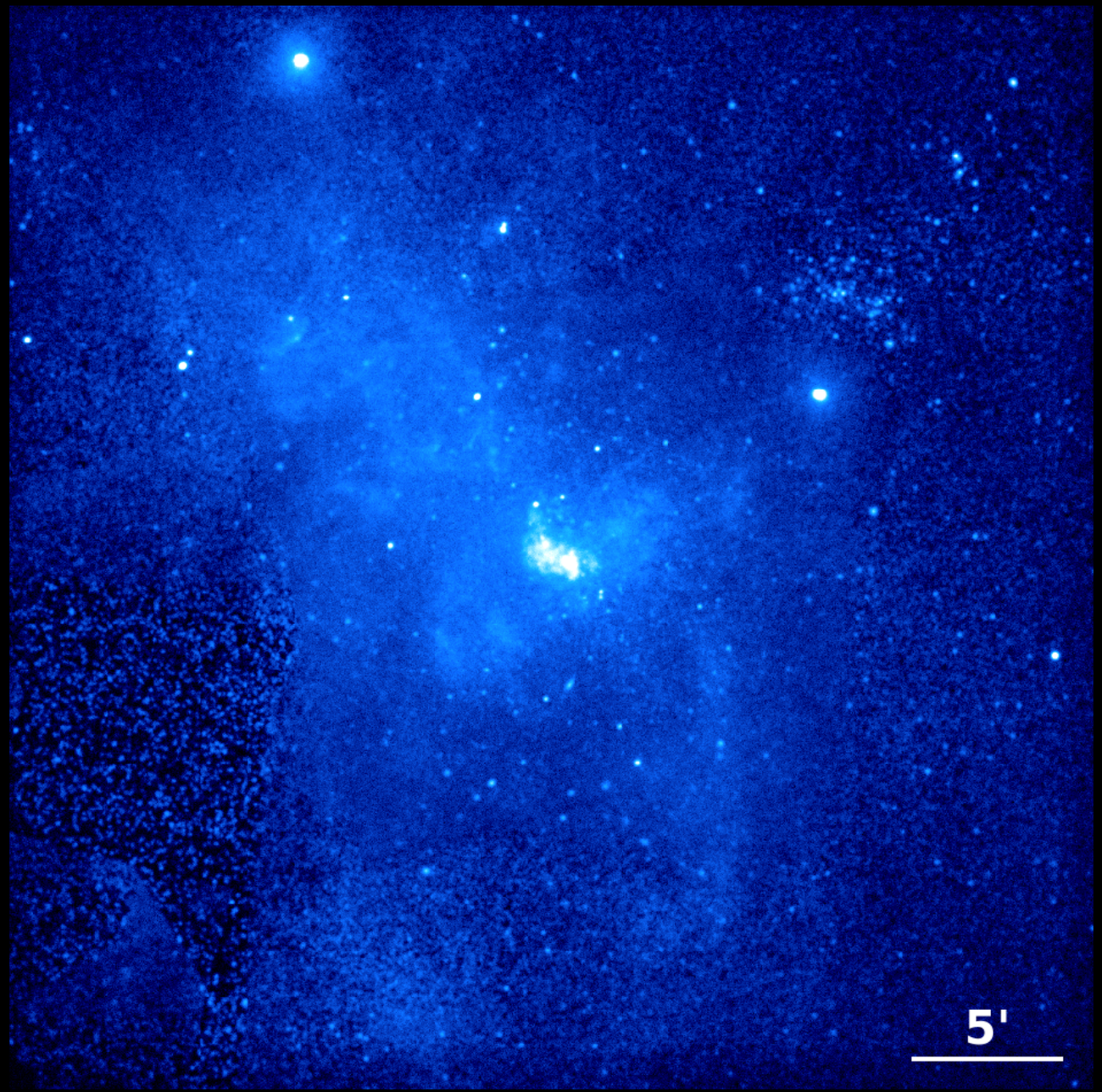



- 1.1 M sources found
- >5k clusters confirmed

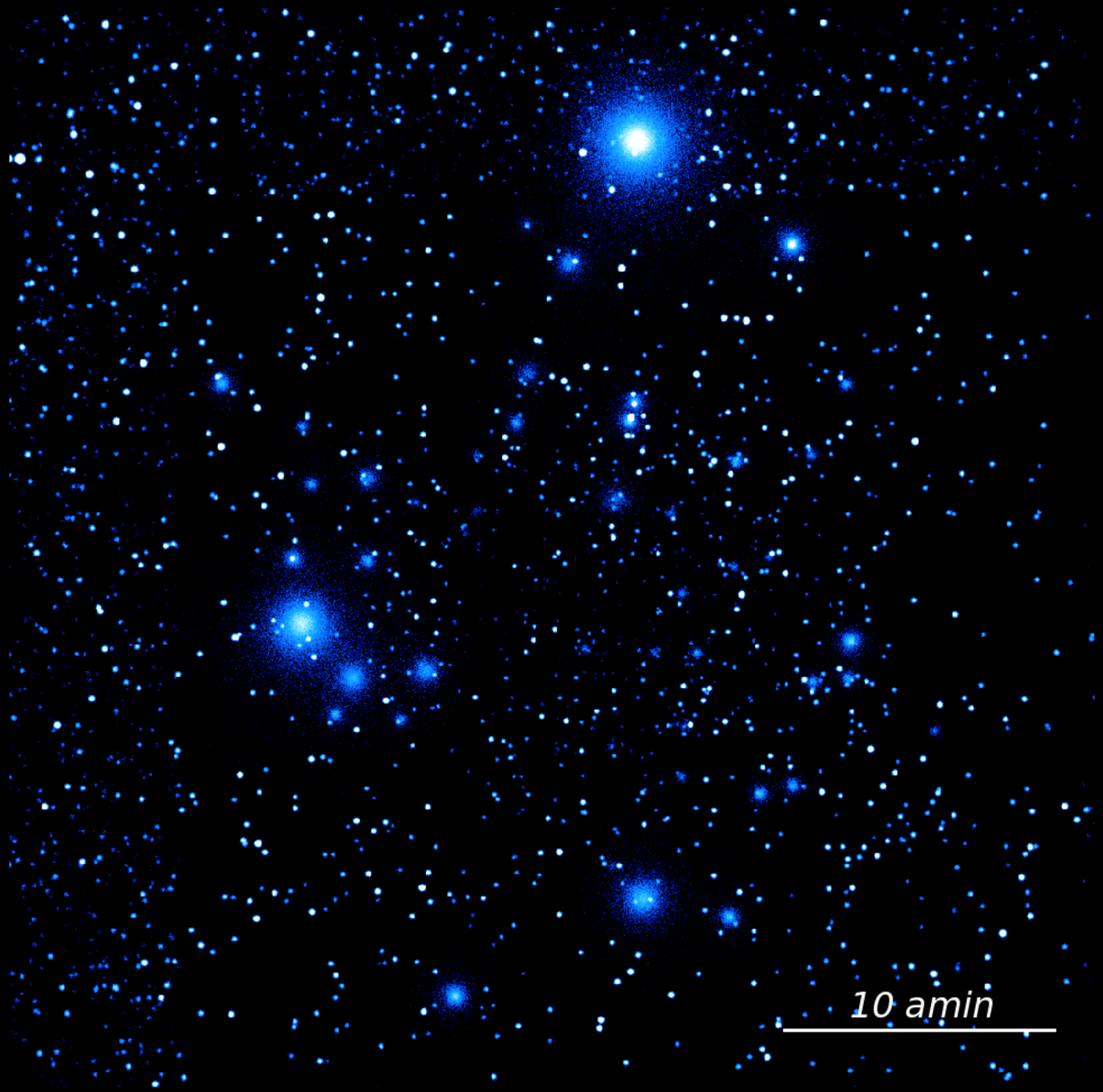
# Projects



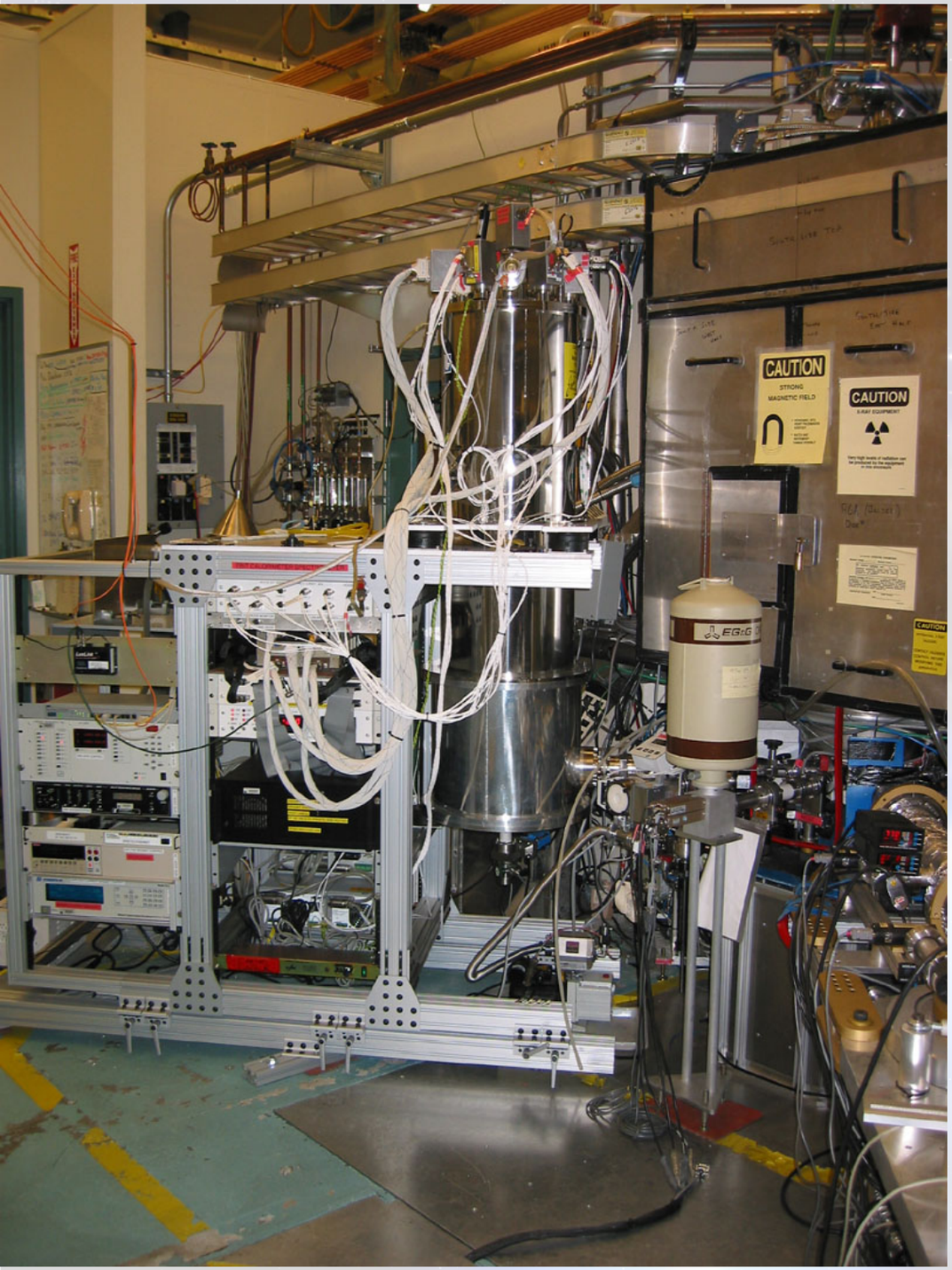
- ESA L3-Mission
- Two Instruments:
  - Wide Field Imager (PI: Kirpal Nandra, MPE): CCD-like instrument Instrument
    other Germans: IAAT, ECAP, (Bonn)
  - X-ray Integral Field Unit (PI: D. Barret, F): Microcalorimeter w/1.5 eV resolution
    Simulations: ECAP
- Science goals: find missing baryons (absorption spectroscopy [O-Lines])
- operated as observatory
- very international (D, F, NL, I, UK, FI, DK, E, P, GR, PL, JP, USA,. . . )

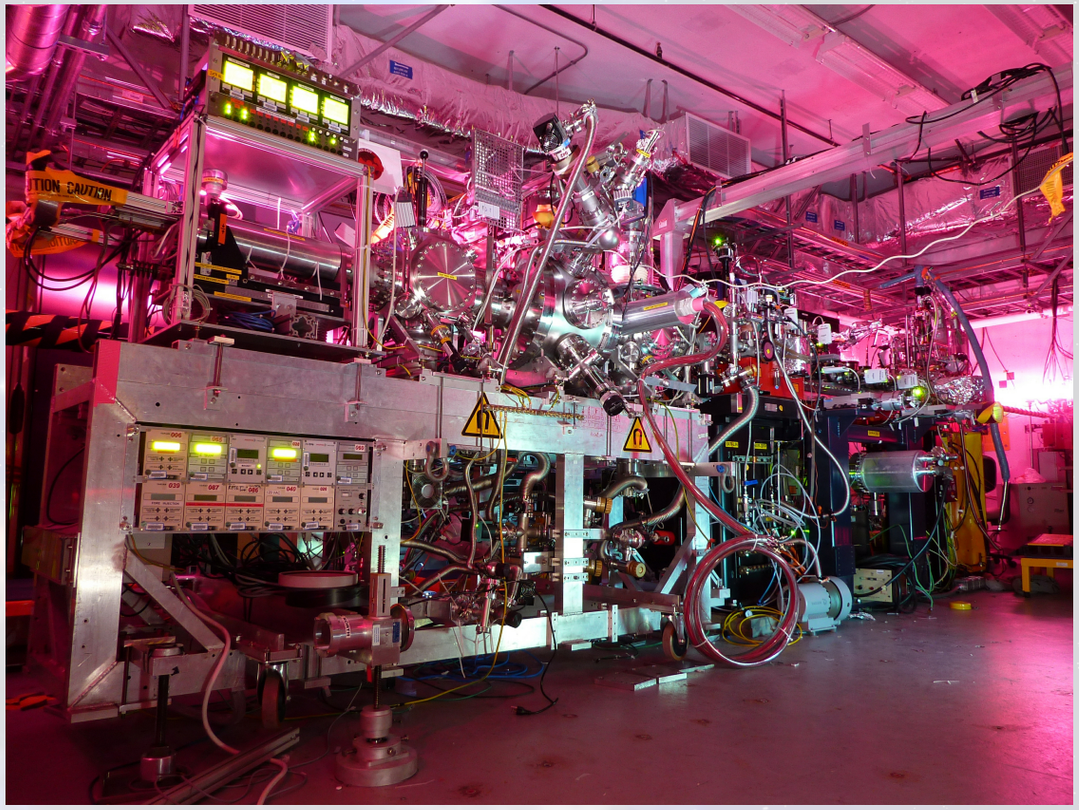



ATHENA WFI: Galactic center




ATHENA WFI: Chandra/Hubble Deep Field



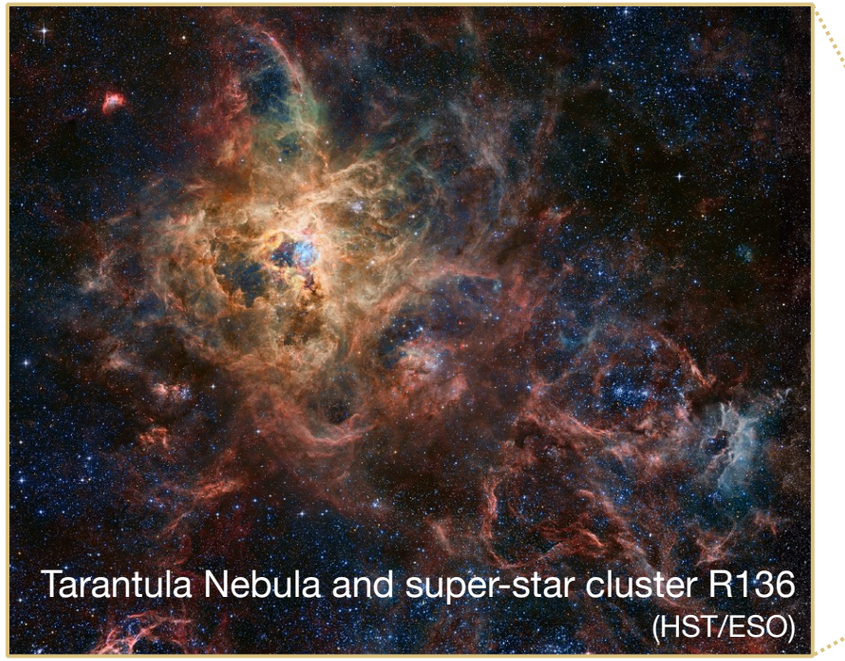



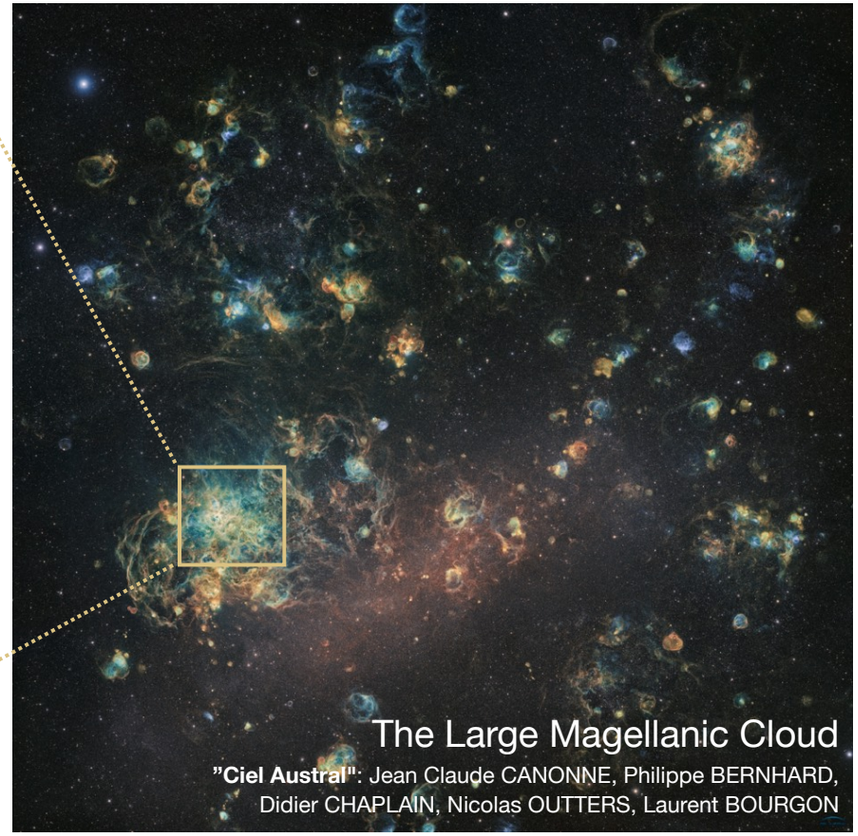

## Laboratory Astrophysics

- Measurement of X-ray line energies and cross sections
- Atomic physics calculations for these ions

Collaboration with Lawrence Livermore National Laboratory, GSFC, MPI f. Kernphysik

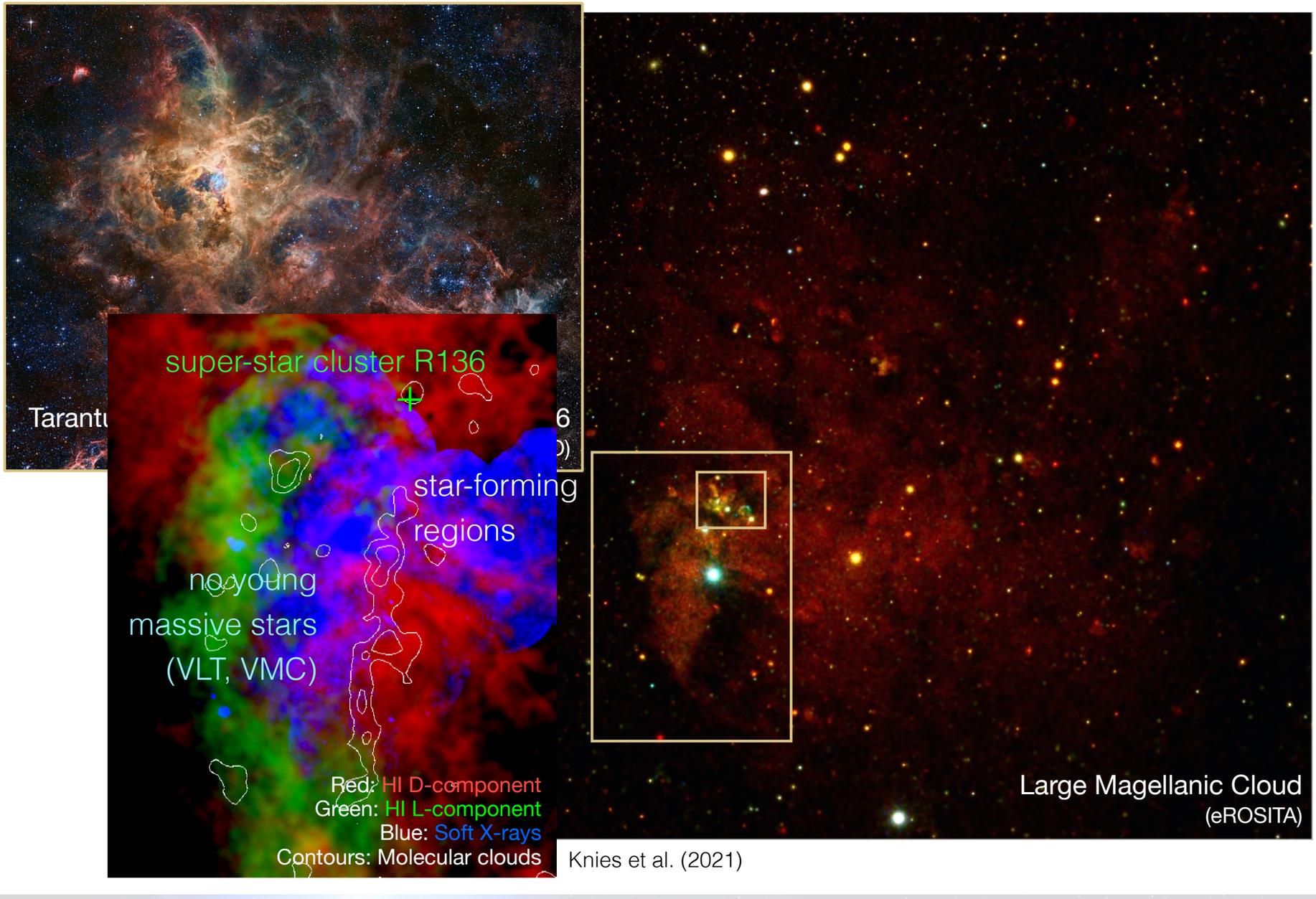
# Interstellar medium



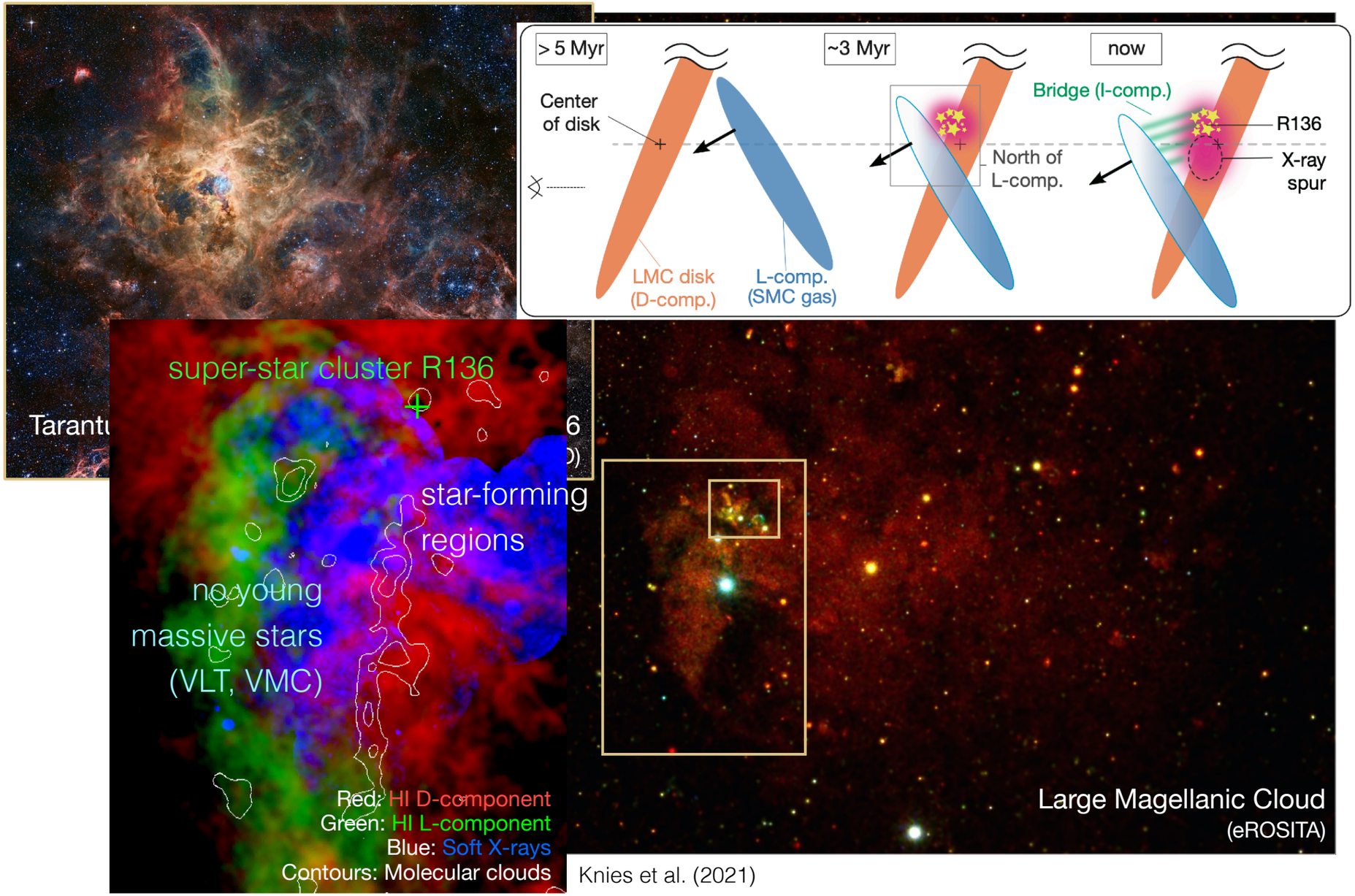

- Consists of multiple phases (molecular and atomic neutral gas, warm partly ionised gas, and hot plasma).
- Cold material condenses to begin star formation process.
- Energy and momentum are deposited throughout stellar evolution.
- Regulates star formation and therefore the evolution of galaxies.

# Cloud collision and star formation in LMC



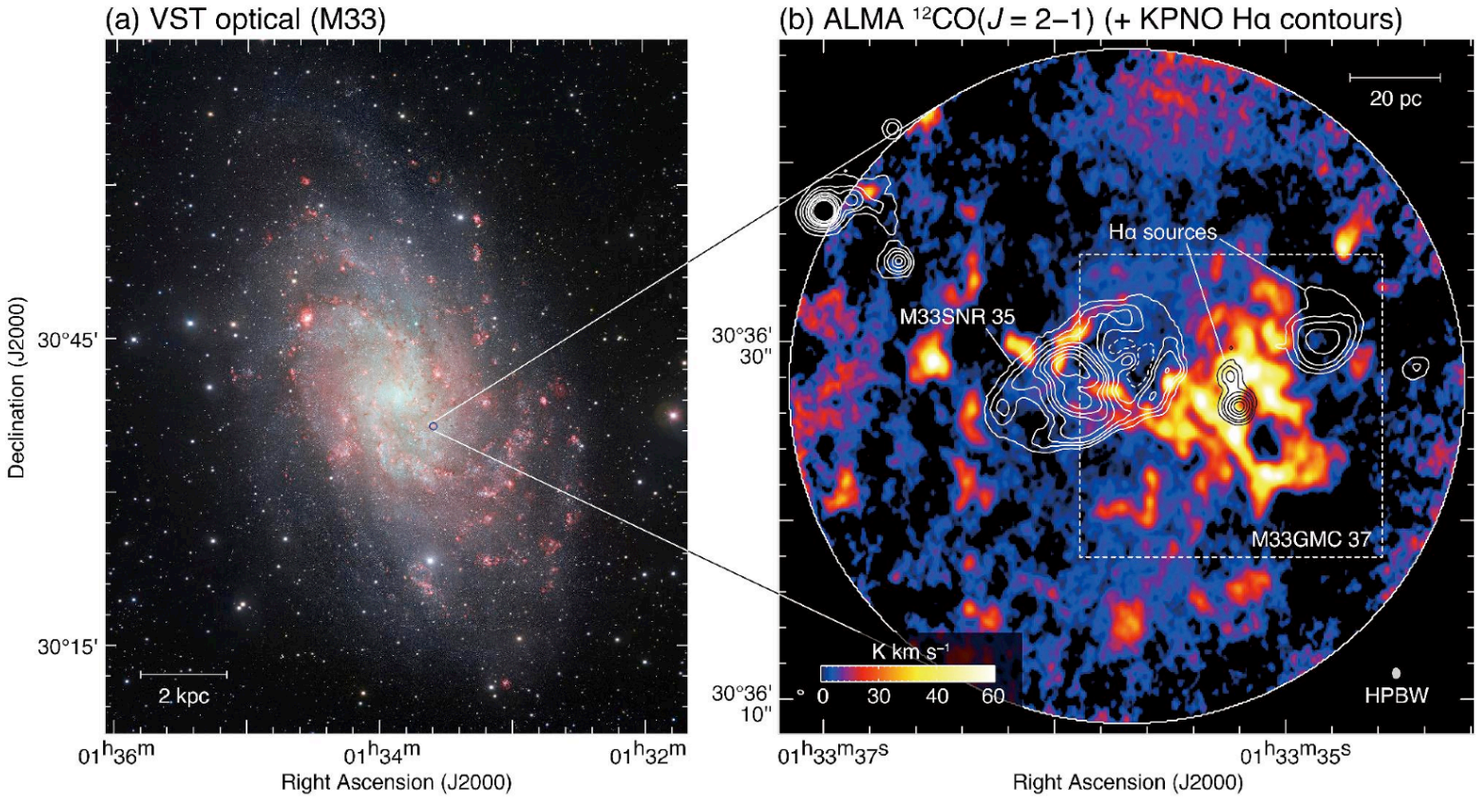

Knies et al. (2021)

# Cloud collision and star formation in LMC

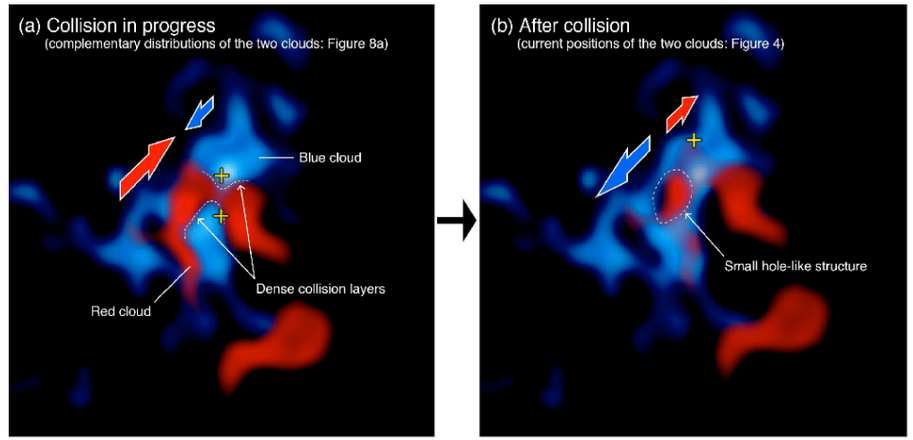



Knies et al. (2021)

# Cloud collision and star formation in M33

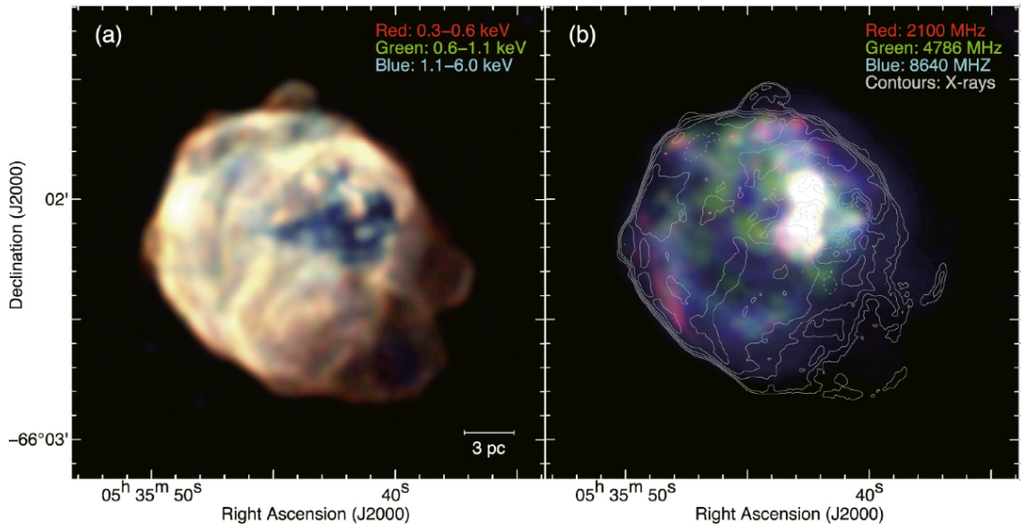


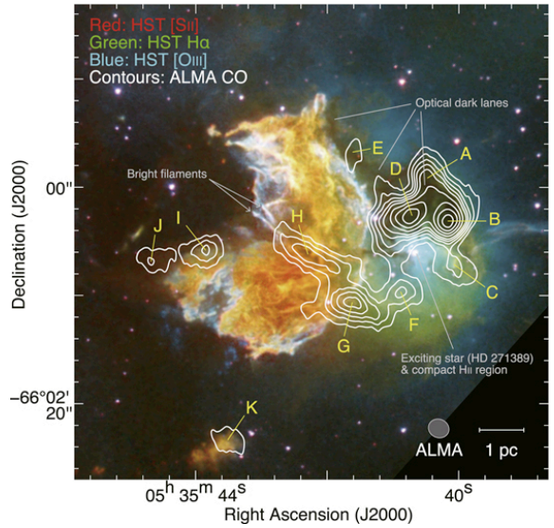

Sano et al. (2021)



# SNR shock interaction with molecular clouds

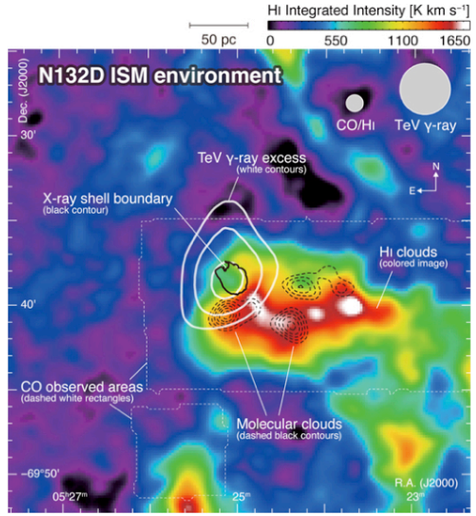
## LMC SNR 63A

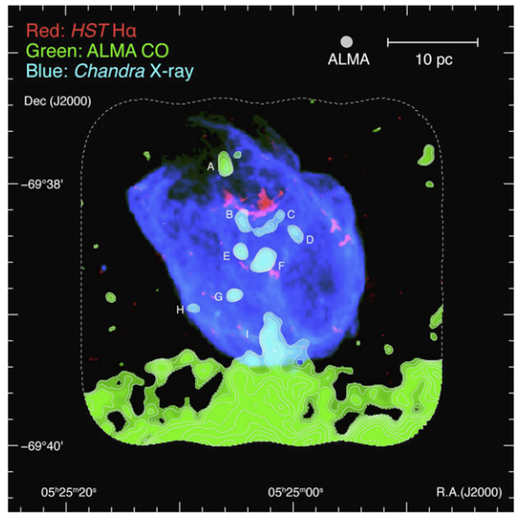


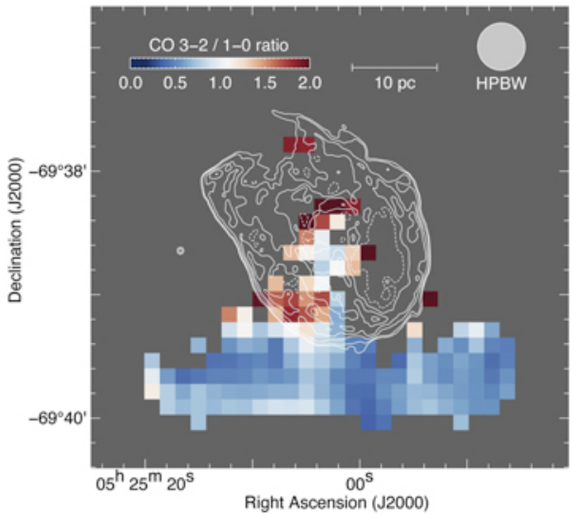




Sano et al. (2019)

## LMC SNR N132D




Sano et al. (2020)