Shining X-ray light on the low-metallicity starburst ESO 338-4

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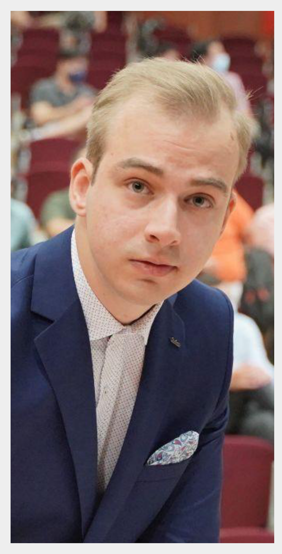


ACIS–I chips

Science case

- Low-metallicity (low-Z) star-forming galaxies are common in the young universe (JWST observations).
- What the ionizing sources in those galaxies are remains an open question.
- Studies of nearby analogues of high-redshift galaxies are needed for the answer:
  - X-ray ionizing sources: High-mass X-ray binaries (HMXB), ultra-luminous X-ray sources (ULXs), and hot superbubbles. *Can be observed with the CXO.*
  - UV ionizing sources: Hot massive stars (OB & Wolf-Rayet stars). *Can be observed with the HST.*
- Such nearby analogues are blue compact dwarf galaxies (BCDs), e.g. SMC with $Z_{SMC} \sim 0.2Z_{\odot}$.

X-ray sources in blue compact dwarf galaxies

- HMXB populations in BCDs are correlated with their metallicity through an X-ray luminosity function (XLF)[2].
- There is a paucity of data at $Z<Z_{SMC}$.

Composite image of the SMC with a HMXB on the right. Photo taken from: chandra.harvard.edu/photo/2011/sxp1062.

[2]Lehmer B. D., Eufrasio R. T., Basu-Zych A., Doore K., Fragos T., Garofali K., Kovlakas K., et al., 2021, ApJ, 907, 17. doi:10.3847/1538-4357/abcec1

Best proxy for high-redshift galaxies: ESO 338-4[3]

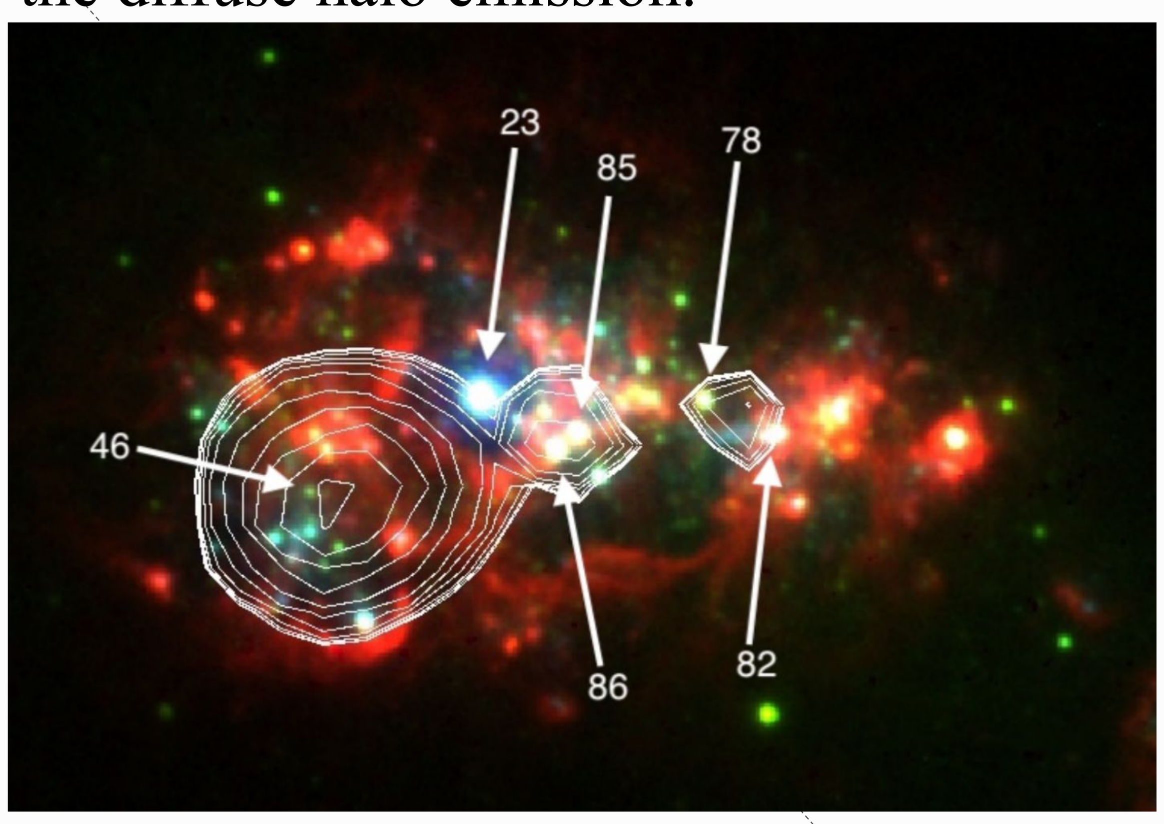
- Distance of 37.5 Mpc. Close enough for detailed deep observations!
- Metallicity of $Z \sim 0.12Z_{\odot}$, similar to the metallicities observed by JWST at high redshift ($z \geq 2$).
- Super massive star clusters. The most massive, Cluster 23, has a mass of $\sim 4 \cdot 10^{6}\ M_{\odot}$.
- Available HST observations complement Chandra data needed to map ionized nebulae in X-ray, optical, and UV. Together, NASA's great observatories will uncover the energetics of this galaxy.

How many X-ray sources are there in ESO 338-4 and how do they affect the ionization of the galaxy?

[3]Bik A., Östlin G., Menacho V., Adamo A., Hayes M., Herenz E. C., Melinder J., 2018, A&A, 619, A131. doi:10.1051/0004-6361/201833916

Aimpoints of this study

- 16 new Chandra ACIS-I observations with a total of 300ks exposure time.
- Joint analysis with XMM-Newton data to detect the diffuse halo emission.



X-ray contours superimposed on an HST RGB image[4].

Three Sources had already been found in 2019. Will there be more? Stay tuned…!

[4]Oskinova L. M., Bik A., Mas-Hesse J. M., Hayes M., Adamo A., Östlin G., Fürst F., 2019, A&A, 627, A63. doi:10.1051/0004-6361/201935414