THE TEACUP AGN IN X-RAYS

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Intro: The "Teacup AGN" (SDSS J1430+1339) is a type 2 quasar at z = 0.085, with remarkable galactic-scale structures of radio emission and ionized gas. The system is an informative case study of the way in which *typical* (radio-moderate) quasars may interact with their host galaxies (e.g., Villar Martín+ 2014, Harrison+ 2015, Ramos Almeida+ 2017). For more on the results in this poster, see Lansbury+ 2018.

THE SUPERBUBBLE

- The Eastern "bubble" (or "handle") of the Teacup is ~10 kpc in size, and luminous in radio and ionized gas (e.g., [OIII]) line emission (e.g., Lintott+2008; Keel+2015).
- At the projected inner base of the bubble lies a 700 km/s [OIII] outflow, coincident with a ~1kpc radio jet (Harrison+ 2015). The bubble is likely driven by jets or winds.
- High resolution *Chandra* imaging reveals X-rays co-spatial with the radio and ionized gas, on scales out to ≈12 kpc.
- The bubble may be a larger-scale, higher-luminosity counterpart to the smaller jet-driven bubbles seen driving shocks around local AGN.

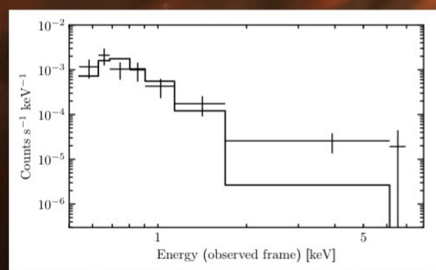


Figure 2: X-ray (*Chandra*) spectrum for the bubble.

- The X-ray spectrum is in agreement with a shocked thermal gas, with T = (4-8) × 10^6 K.
- There is also evidence for a very hot component with T ≳ 3 × 10^7 K. This is a prediction of quasar wind models (e.g., Nims+ 2015) yet to be unambiguously observed.

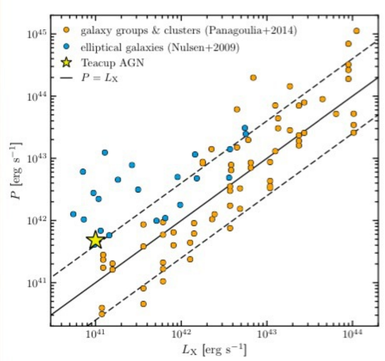
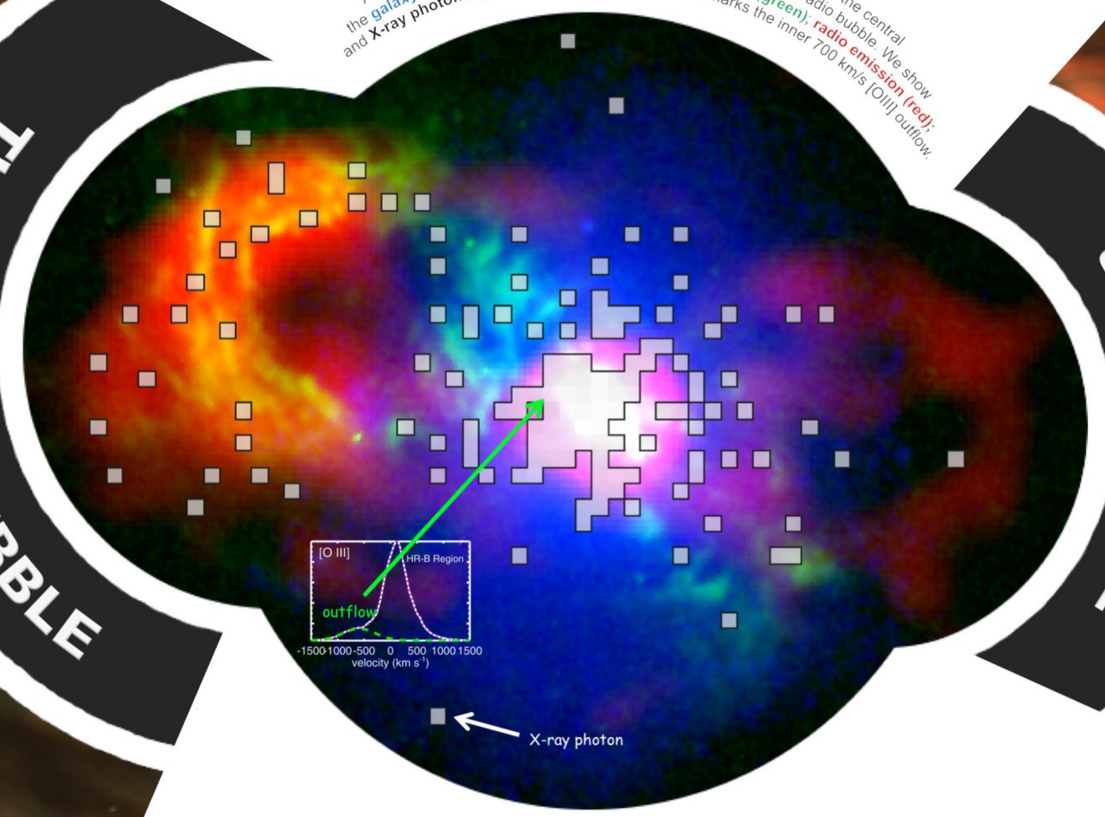


Figure 3: The estimated ratio between the bubble power (y-axis) and the X-ray luminosity (x-axis) is in remarkable agreement with observations of ellipticals, groups, and clusters of galaxies undergoing mechanical AGN feedback. The bubble/cavity morphologies also bear similarities.

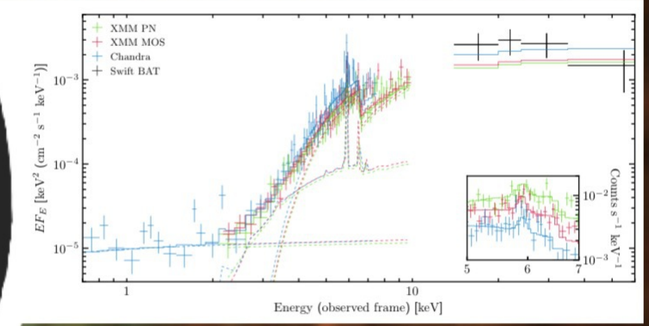
Figure 1: color composite image of the Teacup galaxy, showing the central AGN/quasar, the bright Eastern bubble, and the fainter Western radio bubble. We show the **galaxy optical continuum (blue)**; **[OIII] line emission (green)**; **radio emission (red)**; and **X-ray photons (grey squares)**. The inset figure marks the inner 700 km/s [OIII] outflow.



THE QUASAR

- In the X-ray band, only *Chandra* has the angular resolution required to spatially separate the central quasar from the extended galactic-scale X-ray emission.
- The Teacup has been identified as a potential "faded" quasar (like Hannys Voorwerp) where the AGN has dropped by a factor of ≈50–600 over ~100,000 years, based on the galactic-scale ionized gas requiring a high ***past*** luminosity for the central quasar (L_{bol} ≈ 10^{46} erg s^{-1}; e.g., Gagne+ 2014; Villar-Martín+ 2018; Keel+ 2017). But..

Figure 4: X-ray spectrum for the central quasar from *Chandra*, *XMM-Newton*, and *Swift* BAT. Solid curves show the best fit model, and the inset shows a zoom-in on the Iron Kα line.



- .. The new X-ray spectra, however, show that the central AGN is ***currently*** luminous, with L_{bol} ≈ 10^{45}–10^{46} erg s^{-1}, once we correct for the high column density measured along the line-of-sight (N_H ≈ 5 × 10^{23} cm^{-2}). The Teacup quasar therefore need not have dramatically faded, and is currently capable of providing substantial energy for AGN feedback.

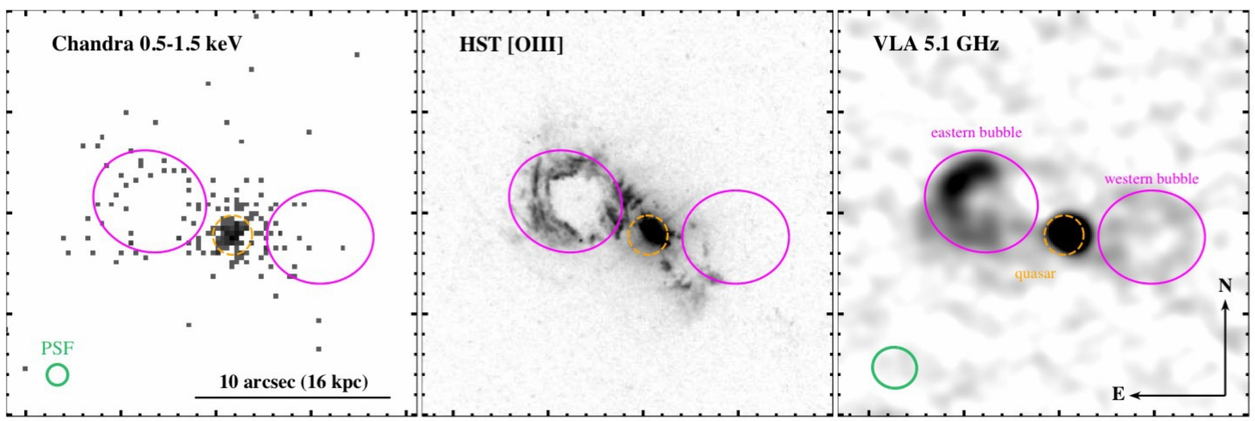


Figure 5: Images of the Teacup from *Chandra* (left), the [O III] narrow band with *HST* (middle; Keel+ 2015), and the VLA at 5.12 GHz (right; Harrison+ 2015). These data are also shown together in Figure 1.