Disentangling the Circumnuclear Environs of Centaurus A: Gaseous Spiral Arms

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We report the existence of spiral arms in the recently formed gaseous and dusty disk of the closest giant elliptical, NGC 5128 (Centaurus A), using high resolution ^{12}CO(2–1) observations of the central 3′ (3 kpc) obtained with the Submillimeter Array (SMA) [1]. This provides evidence that spiral-like features can develop within ellipticals if enough cold gas exists.

We elucidate the distribution and kinematics of the molecular gas in this region with a resolution of 4.″4 × 1.″9 (80 pc × 40 pc). From the ^{12}CO(2–1) emission distribution in Fig. 1, we confirm that the molecular gas is preferentially located along two filamentary structures resembling spiral-arm-like features to the SE and NW of the circum-nuclear gas (< 200 pc). The larger field of view of our observations demonstrates that these filamentary structures extend at least 1.″0, and they are curved toward the NE and SW. The general properties of the arms are similar to those in spiral galaxies: they are trailing, their width is ~500±200 pc, and the pitch angle is ~20°.

A consequence of the compression produced by these spiral arms is that it is expected to trigger star formation (SF) on the leading edge. This is consistent with abundant SF traced by Paα, coincident at least with the southern molecular spiral arm (nearest part and thus likely the least obscured). The spiral features seen in the ^{12}CO emission is also associated with the distribution of certain tracers observed in poorer angular/spectral resolution maps, such as the SCUBA 450 μm emission map as well as the pure rotational line of molecular hydrogen H_2 (J = 2–0) S(0) (28.22 μm) emission observed with Spitzer/IRS [2]. The molecular hydrogen transition H_2 (J = 2–0) S(0) indicates the presence of gas with T ~ 200 K, which is likely tracing photodissociation regions associated with abundant SF.

A small perturbation could have triggered this spirality, such as a non-axisymmetric weak potential [3] or a minor merger after the disk was relatively well settled. From the HI structure and kinematics [4] we infer that the formation of spiral arms took place in less than 0.3 Gyr, which is likely the most accurate measure of time at our disposal since HI is one of the most sensitive components of interaction. Simulations of gas fueling in the deep potentials of giant ellipticals are needed to investigate the response of the gas under these conditions.

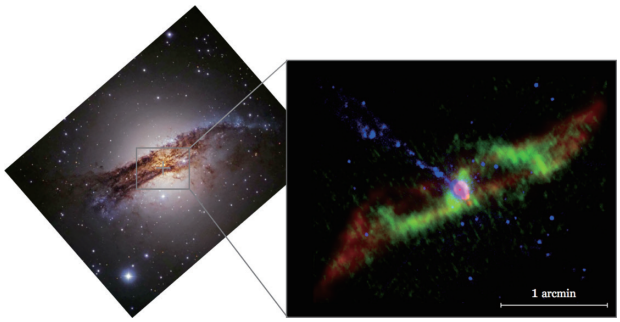

Figure 1: Left) Optical image of Centaurus A, showing its prominent dust lane. Right) The molecular gas as traced by our SMA CO(2–1) observation (green), PAH and dust emission at 8 μm observed by Spitzer (red, [5]), and the Chandra X-ray observations of the jet (blue). Note that the spiral and the 8 μm emission in this panel are within the optical dust lane visible in the left panel. The most prominent features of the ^{12}CO(2–1) emission are consistent with those of the 8 μm emission, but the CO shows the spiral arms.

References

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