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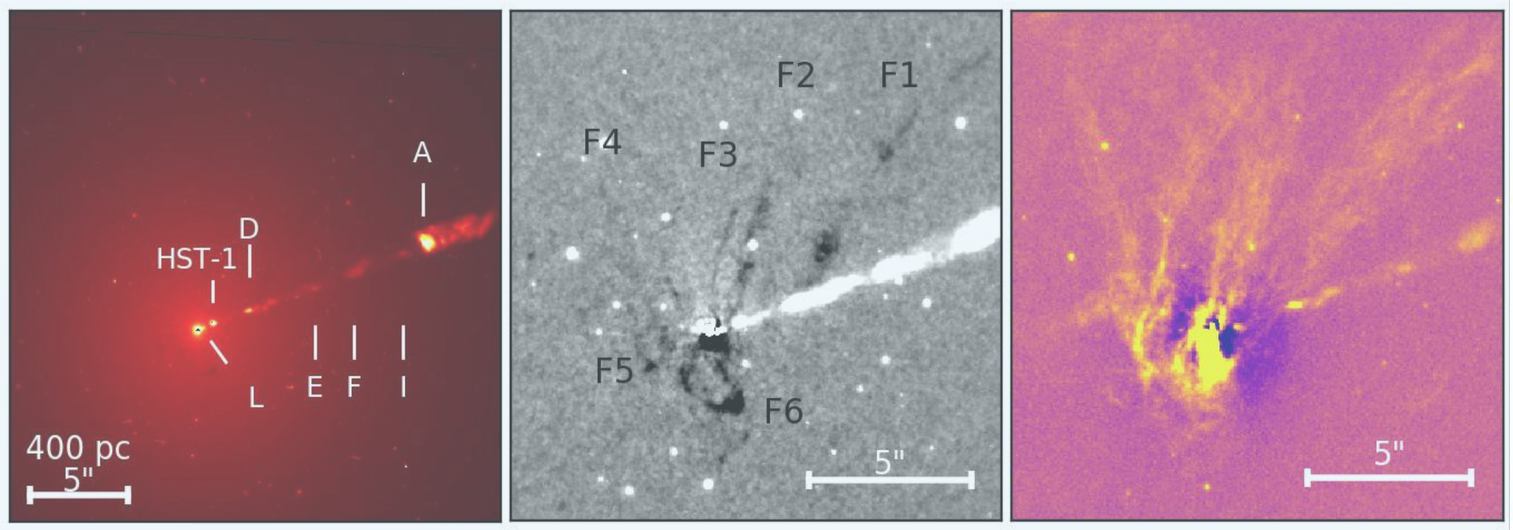
I know the stars are wild as dust
and wait for no man's discipline
Leonard Cohen

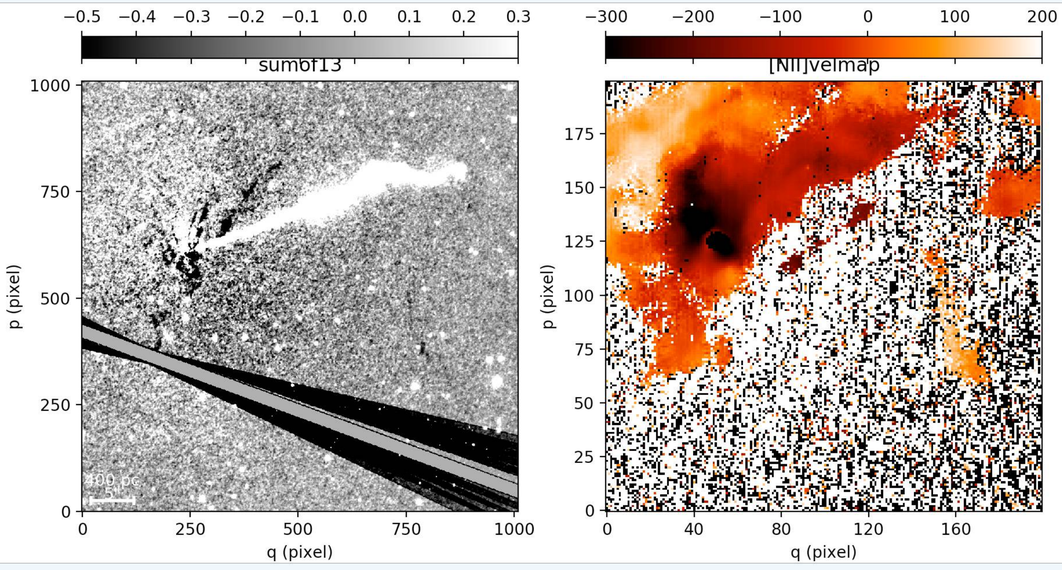
M87 – The Wild Jet

DUST is ubiquitous in early-type galaxies, but the classic dust producers supernovae and/or AGB stars cannot have been at work in those old populations. A common way out is the assertion of infall of dust by merger events. It has been already shown in the case of the putative merger remnant NGC 1316 (Fornax A), that its spectacular dust features are due to nuclear dusty winds (Richtler+2020). The dust in the central region of M87 is less spectacular, but not less interesting. It must have formed in situ, because there is no stellar component of any assumed infall. It rather points out the role of magnetic fields for dust formation and invites an unusual view onto the jet. Data: ACS/UVIS/WFPC2 images, MUSE wide-field and narrow-field mode.

Left: The jet and it knots, HST-1 still flaring (HST/ACS F475W) PI: P. Côté.
Middle: 13 stacked HST/UVIS exposures, galaxy light subtracted, note the dusty filaments seemingly launching from knots HST-1 and D, PI: M.Shara

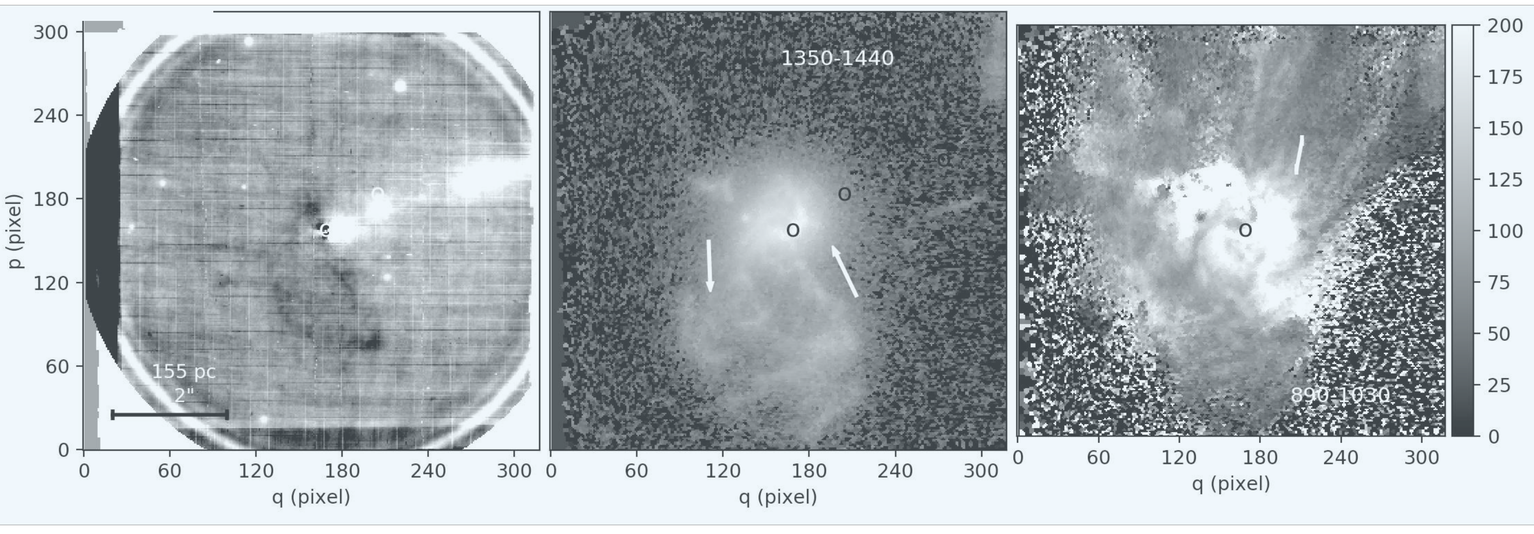
Right: [NII]6583 filter, but redshifted to Hα. All dusty filaments have their gaseous correspondence, but not vice versa. This exact match must have a local origin.

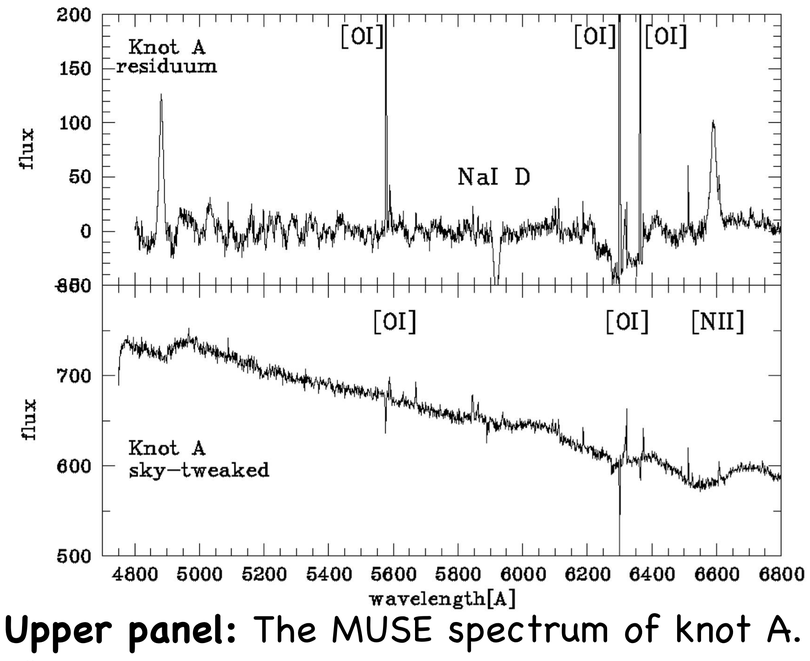




Left: UVIS image, larger scale to let the fine dusty arc be visible, contacting the tip of the jet. **Right:** [NII] radial velocity map relative to the systemic velocity of 1290 km/s from MUSE (wide field mode, science ver.). See Osorno+2023 for the analysis of the central velocity field. Inflows/outflows are only distinguishable with an additional assumption about the filaments' inclination. Inclined towards the observer would mean outflows for the dusty filaments F1-F3, against the gravitational pull of the SMBH. The arc-like filament would be inflowing. Note the straight "knotty" [NII] feature, whose knots correspond with knots A,F,E of the jet.

Left: MUSE narrow field mode (PI: N.Nagar), filament F6, galaxy light subtracted. Pixel scale is 0.025"/pix.
Middle: [NII]-map in the velocity window 1350-1440 km/s. Circles indicate nucleus and HST-1. Arrows indicate the gas flow with inclination towards the observer. Note the narrow [NII] feature parallel to the jet, corresponding here to knot D.
Right: Velocity dispersion map of [NII] in the velocity window 890-1030 km/s. The dust filaments show very low dispersion values which can be understood **by confinement within magnetic fields.**





Local Dust Formation in M87

The cooling time of the X-ray gas is about 10^6 y. Magnetic fields foster the formation of molecular gas (e.g. Heitsch+2008) from which dust may form rapidly (e.g. Sarangi+2019). Dust grains are magnetically shielded from being sputtered.

In that sense, dust forms in the magnetosphere of the black hole, therefore the apparent relation with the jet. Star formation may occur at a rate too low to be detected.

Upper panel: The MUSE spectrum of knot A. Galaxy template fitting and subtraction leave strong Balmer residuals as artefacts. The NaID residual indicates cold gas in the environment.
Lower panel: simple sky-tweaked spectrum. Only continuum with auroral [OI] lines remains (plus unidentified emissions).

Heitsch+2008, ApJ 683, 786
Osorno+2023, A&A 679A,37O
Richtler+2020, A&A 643A, 120R
Sarangi+2019,ApJ 885,126S

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