The central parsec of AGN: challenges to the torus

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IAC

Puerto Varas, December 2018

PARSEC project

Multiwavelength study of the centre of the nearest galaxies at PARSEC scales ($\theta < 0.5$”):

- from active to quiescent

Sampling: Chandra – HST – (AO-NIR + MIR) – SMA /ALMA – VLA /ATCA

<~0.1”

With J.A. Fernandez Ontiveros, A. Rodriguez-Ardila, M. Mezcua, S. Markoff, M. Schartmann, K. Tristram,, A. Burkert, K. Dolag and friends

alternative to the TORUS

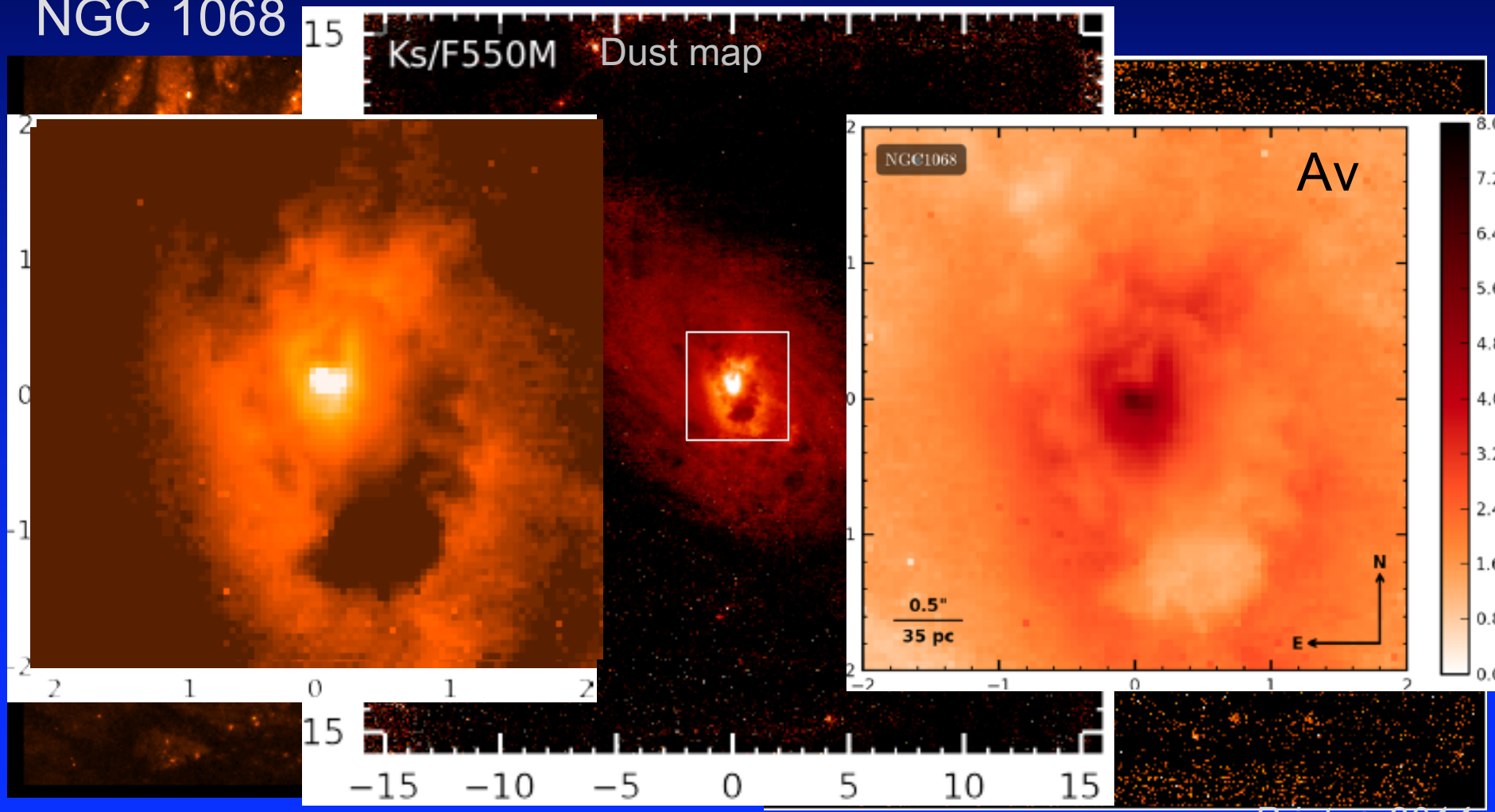
- ✓ Dust filaments and lanes are ubiquitous to centre of galaxies
- ✓ They origin at kpc distances, at the centre they often cross the AGN and obscure it.
- ✓ Their role:

1. they may naturally cause the type 1 / 2 classification in AGN

2. they transport material from kpc distance to the centre ignite both nuclear star formation and feed the hole

The central kpc in a typical AGN

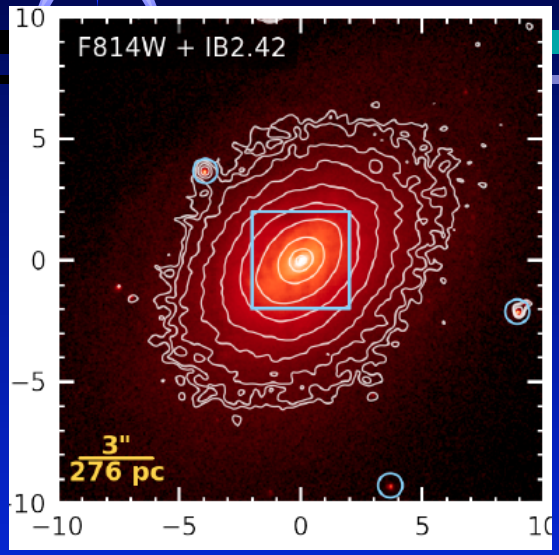
NGC 1068

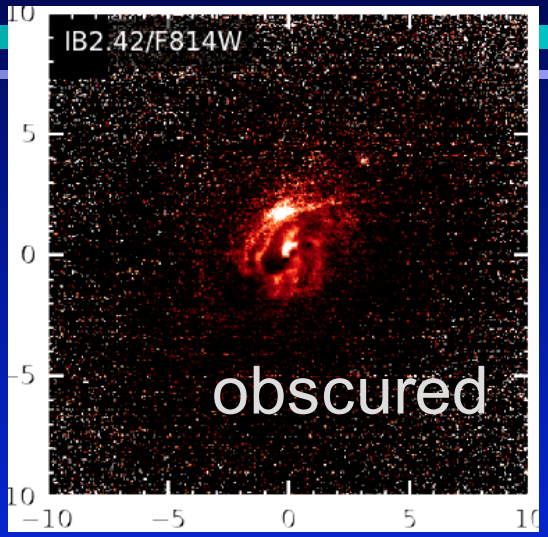


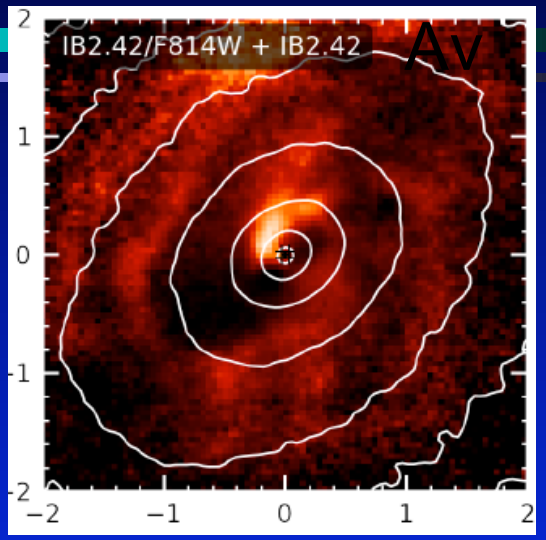
Prieto+ 2014

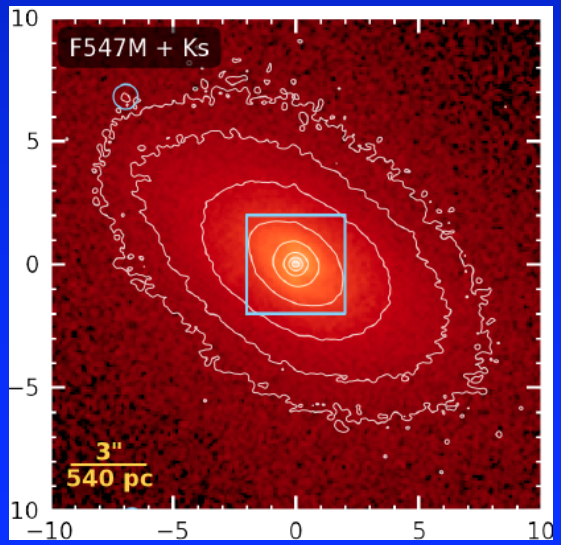
… and in more normal type 2:

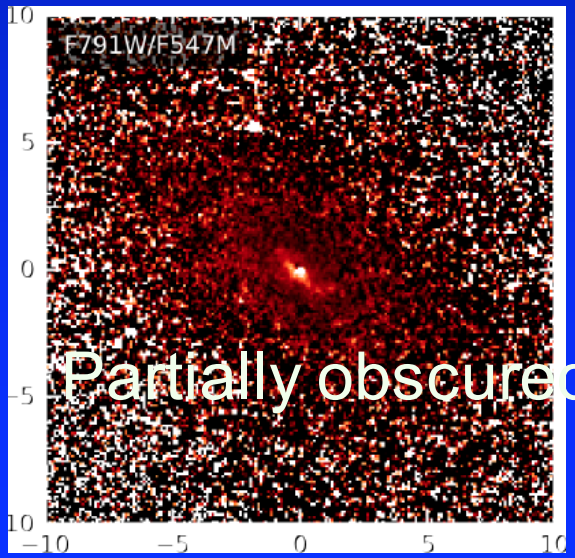
ESO 428-G14 (*Lbol ~10^{42}*) and MCG-5-23-16 (*Lbol ~ 10^{43}*)

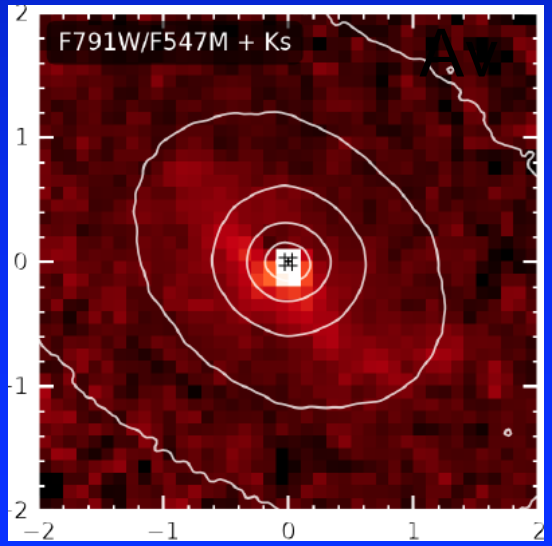












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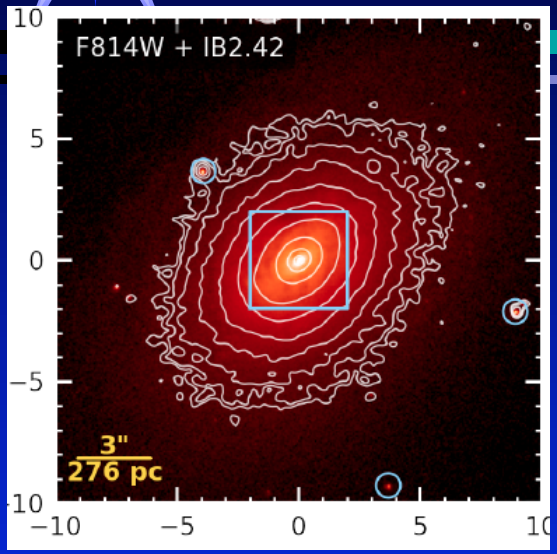
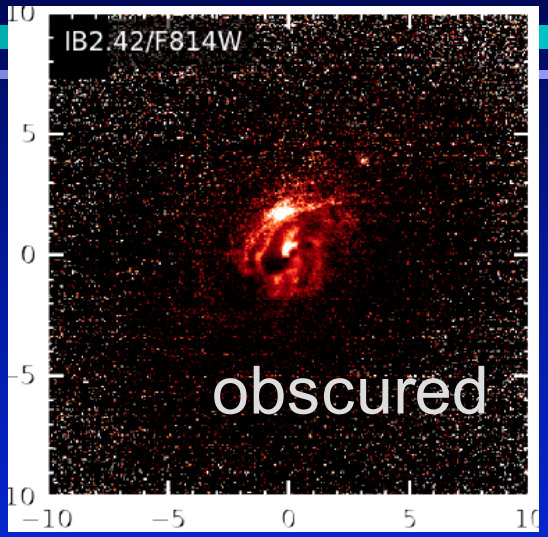
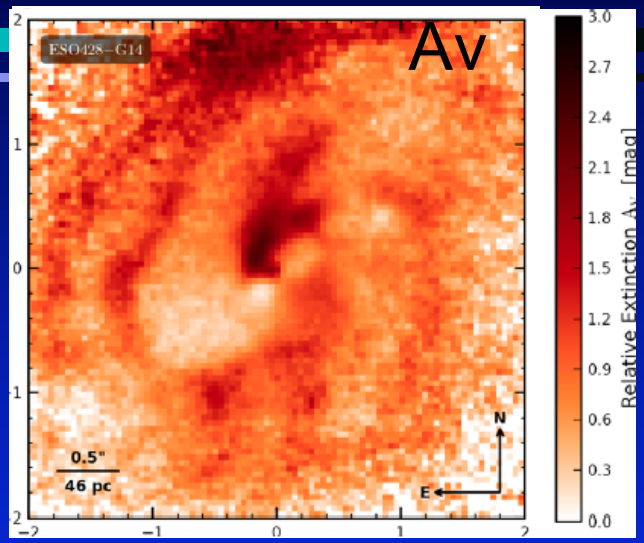
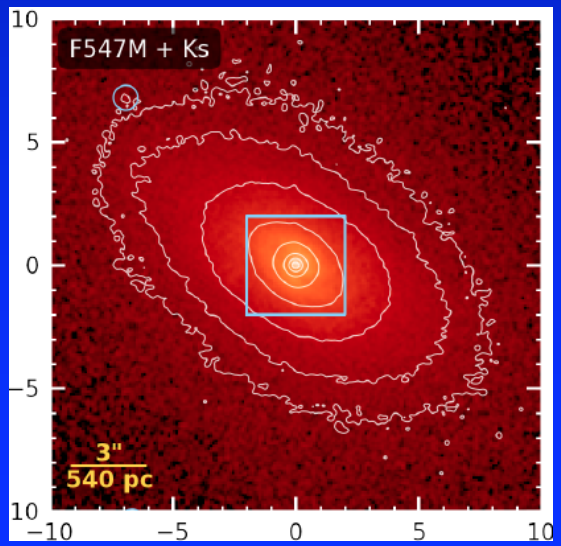
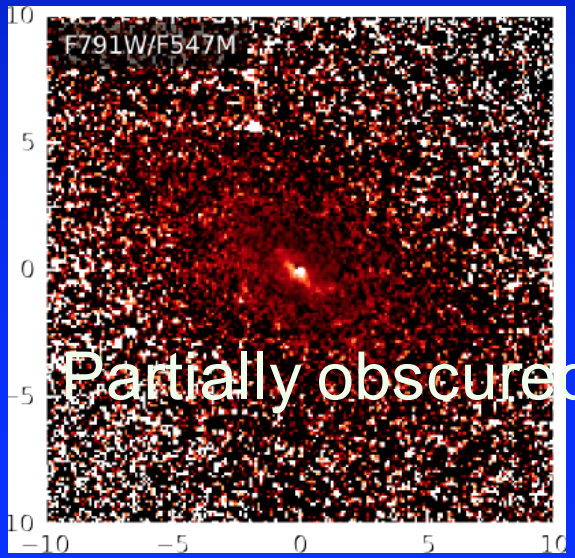
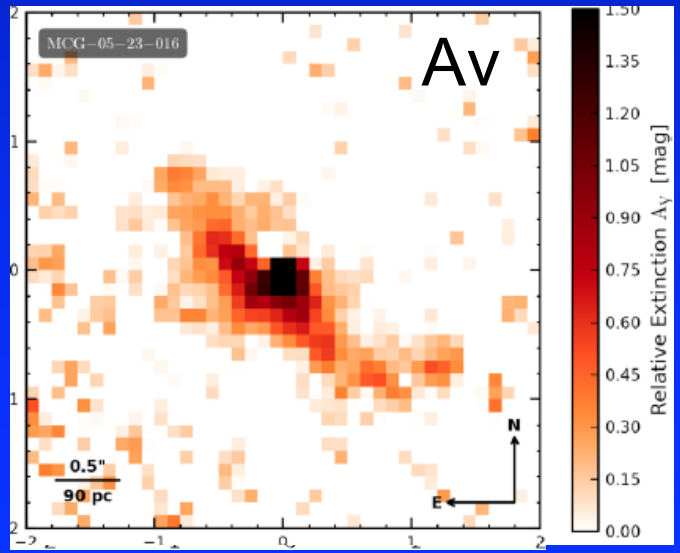






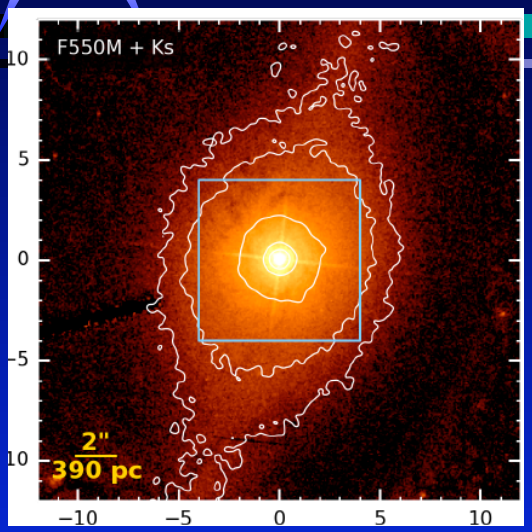


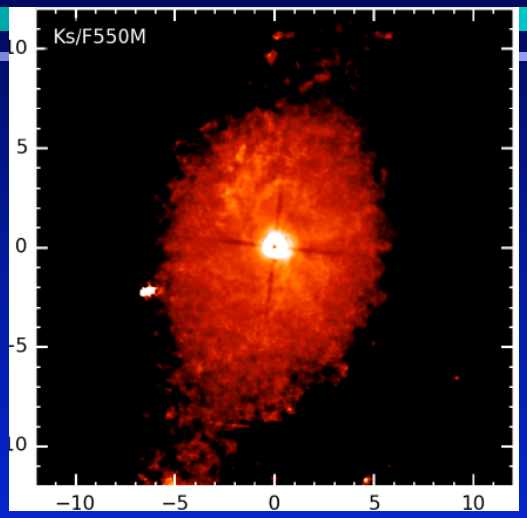


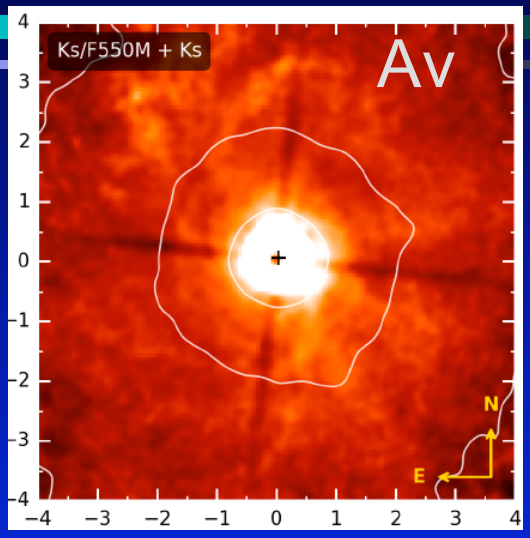


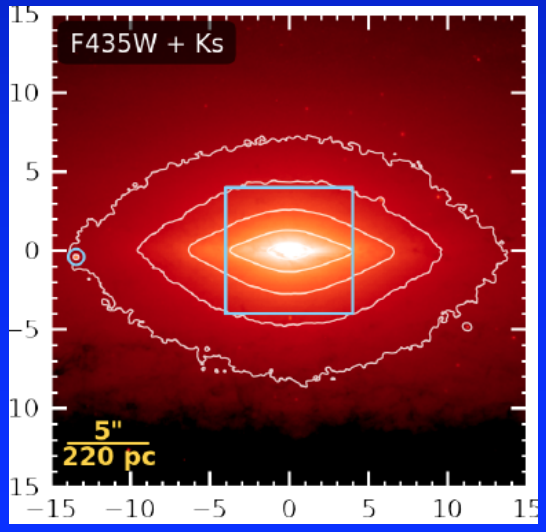
from kpc to pc: dust in type 1 as well….

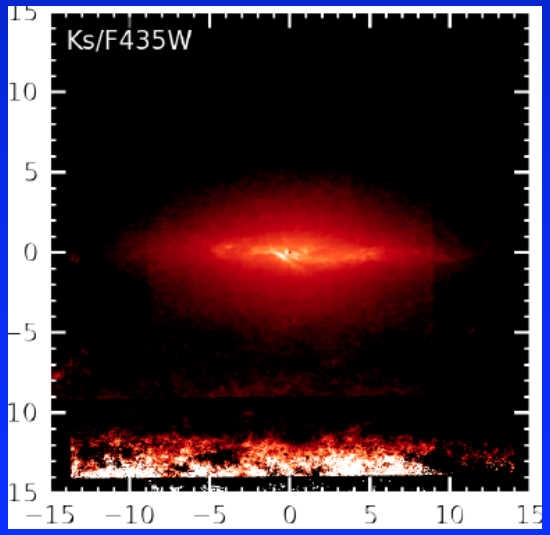
NGC 3783 (*Lbol ~10^{44}*) and Sombrero (*Lbol~ 10^{42}*)

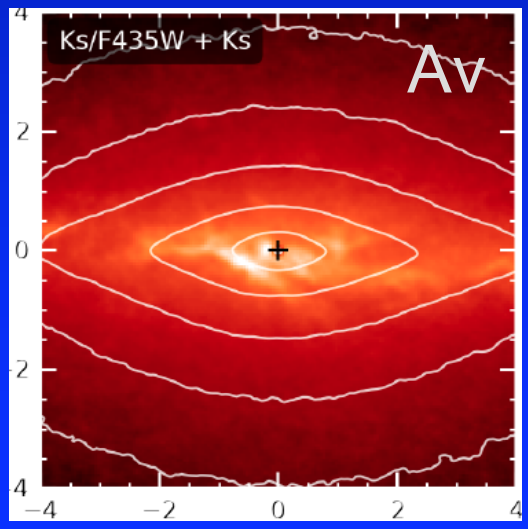












Prieto+ 14; Mezcua+ 15; Nadonly+17

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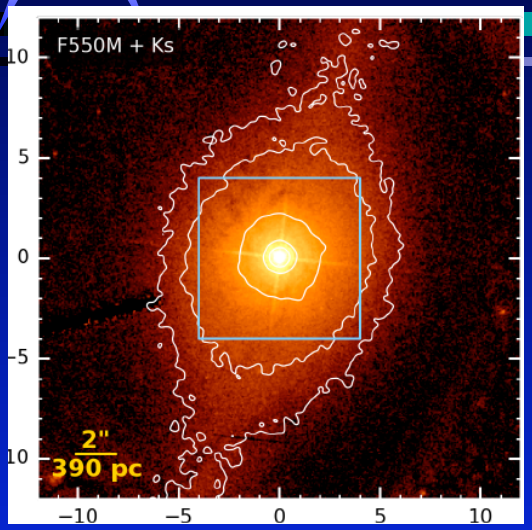

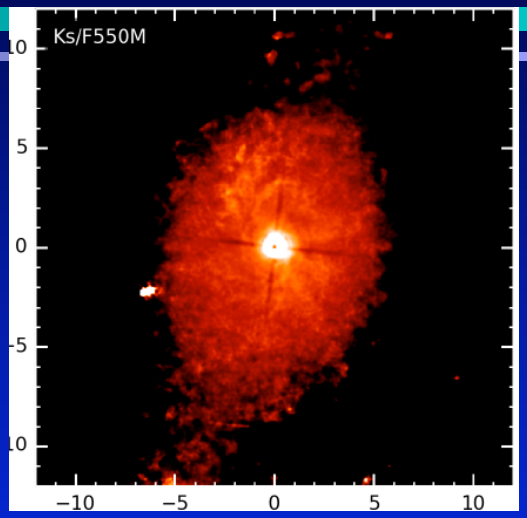

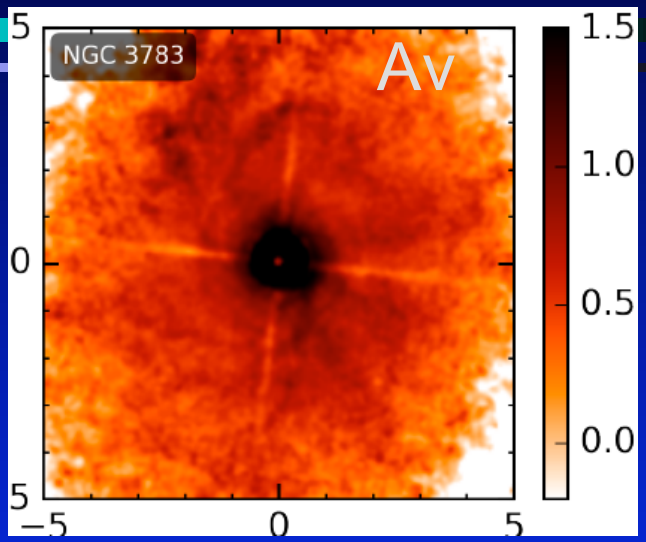

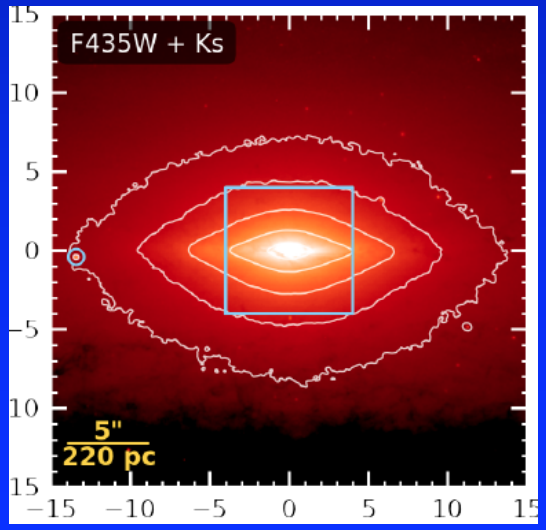

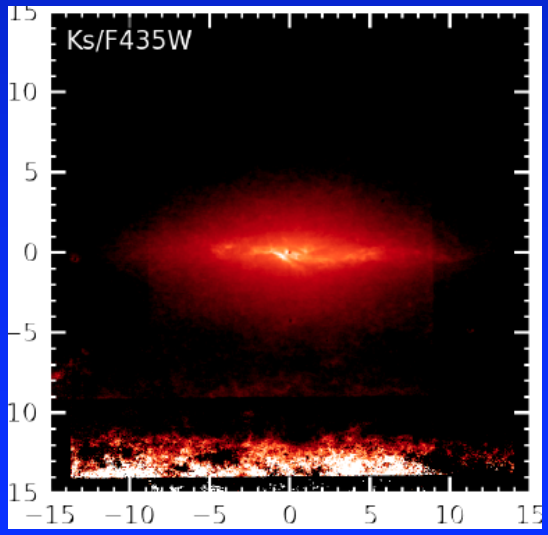

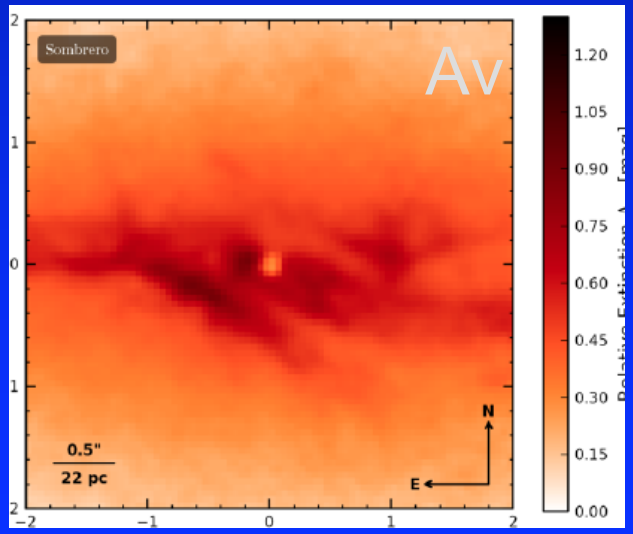

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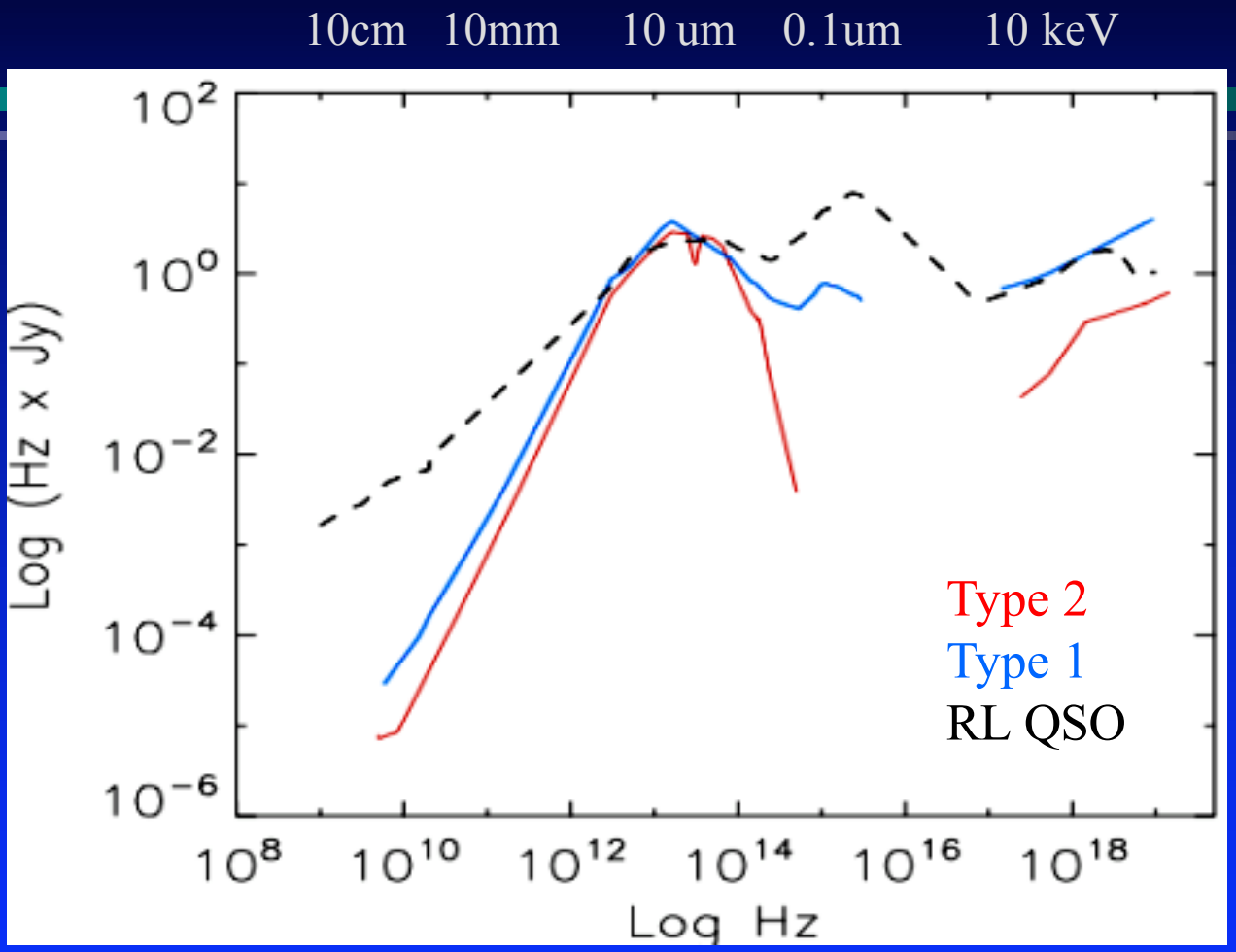
SED templates of the nearest AGN: 10 pc resolution

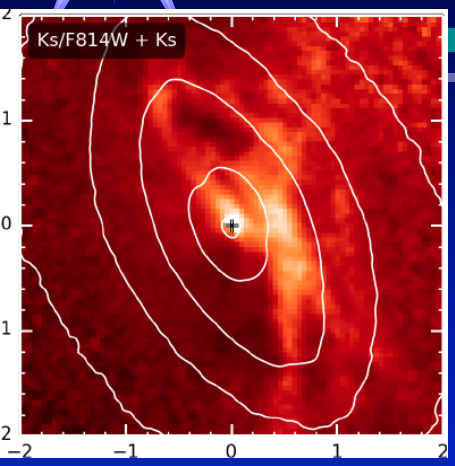
Prieto et al. 2010

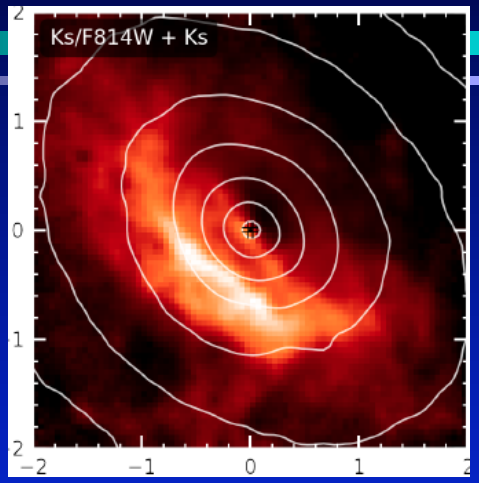


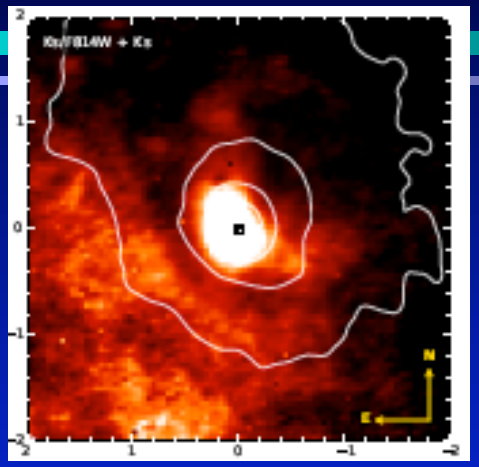
The SEDs show a smooth transition from T2 (fully obscured) to T1 (partial obscuration) to QSO (low dust attenuation)

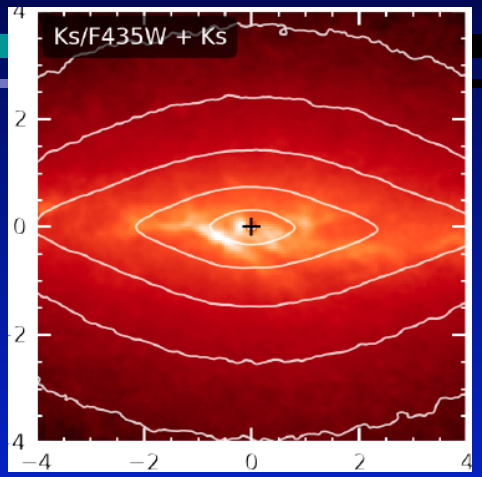
… demystifying ionization cones

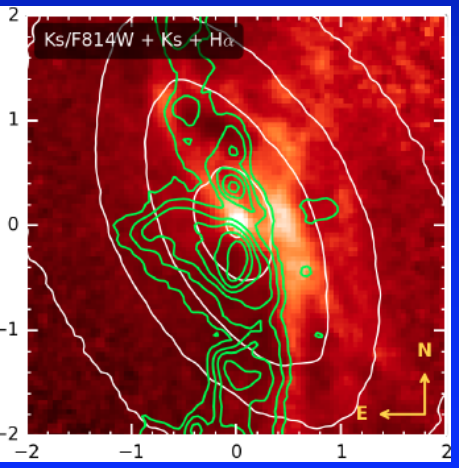
NGC 1386, NGC 3169, Circinus and Sombrero

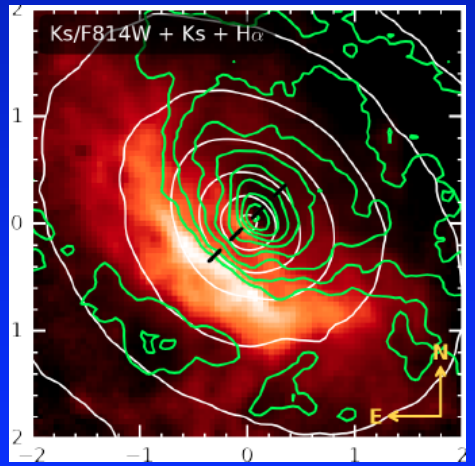


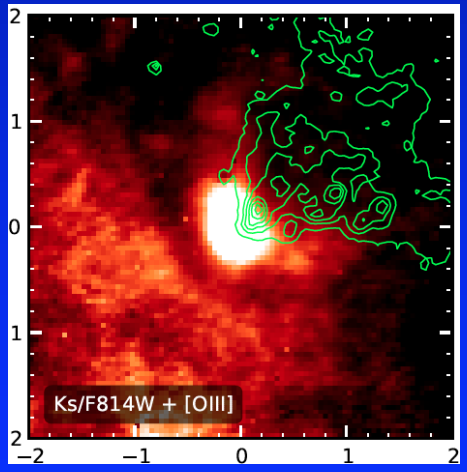


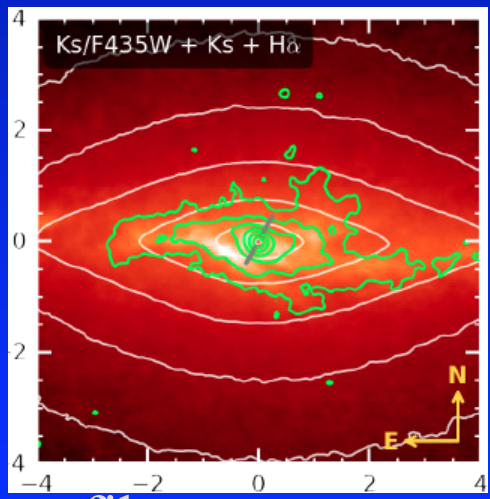








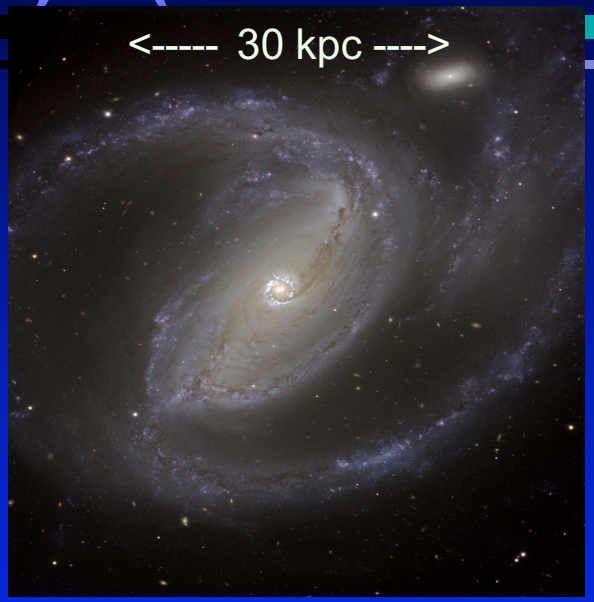


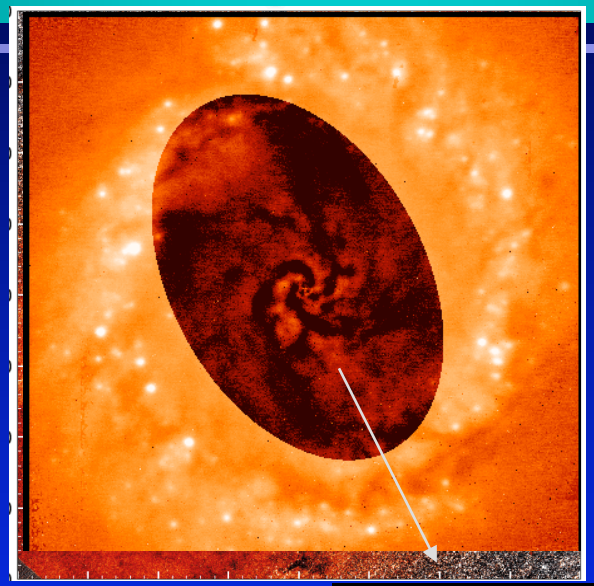


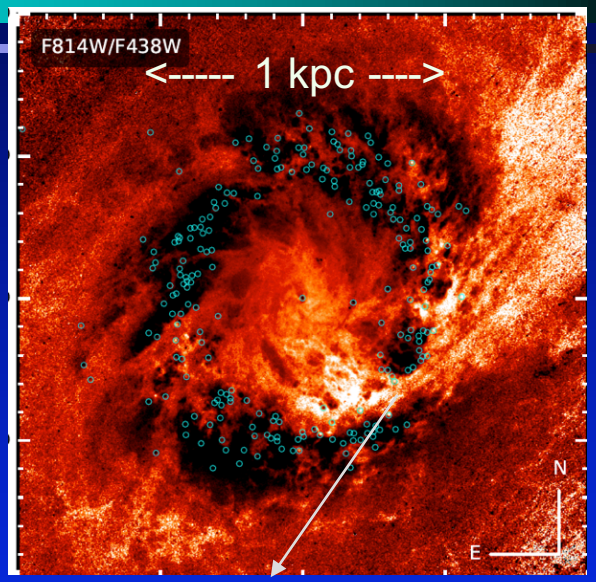
Ionized gas morphology strictly defined by the dust filaments

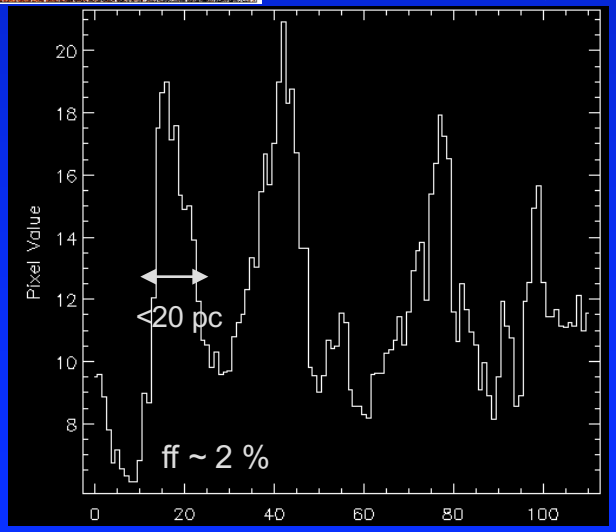
Prieto+14; Mezcua+16; Nadonly+17

Dust filaments: on their structure







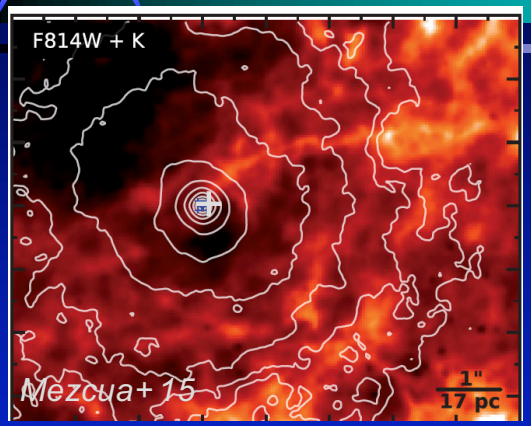


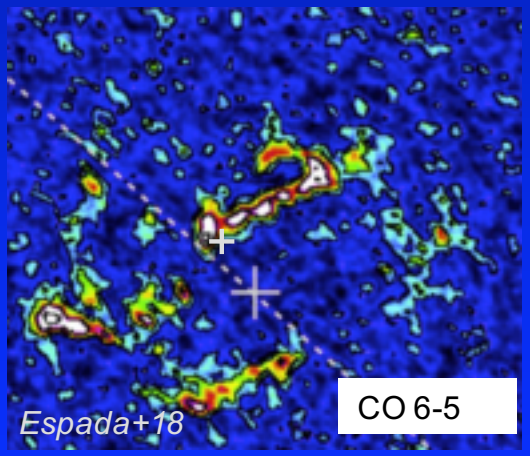
Lane filling factor ~ 2 %
(~ 10 x ff ionised gas)

$Ne_{filaments}$ ~> 200 cm-3

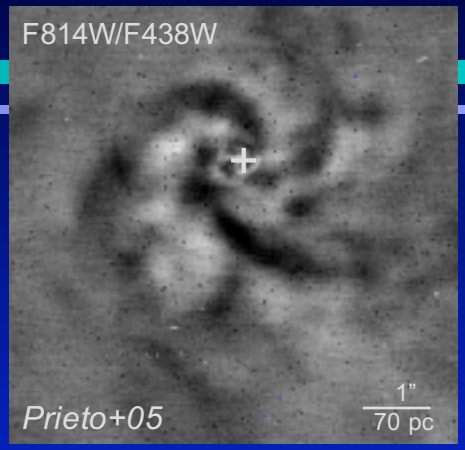
Dust filaments: on their nature

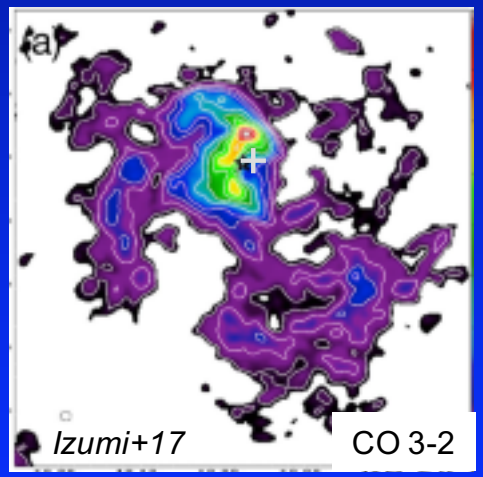
Cen A





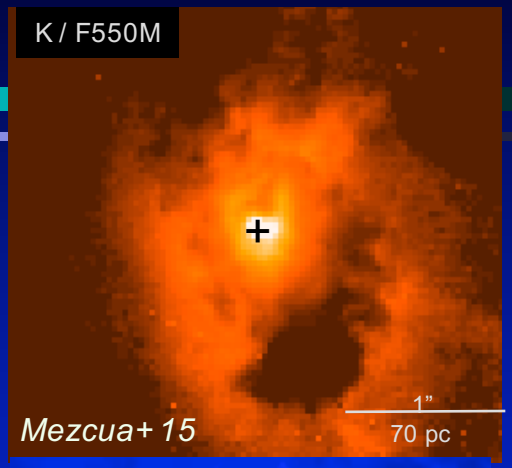
NGC 1097

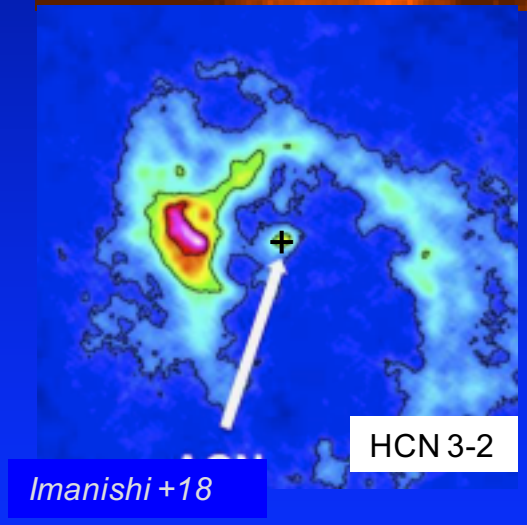




CO inflow rate ~0.2 Mo/yr (Fathi+13)
HCN inflow rate at the ring: ~ 3 Mo/yr (Prieto+16)

NGC 1068





H_2 inflow rate ~15 *Mo*/yr (Muller-Sanchez+09)

Dust filaments: on their nature

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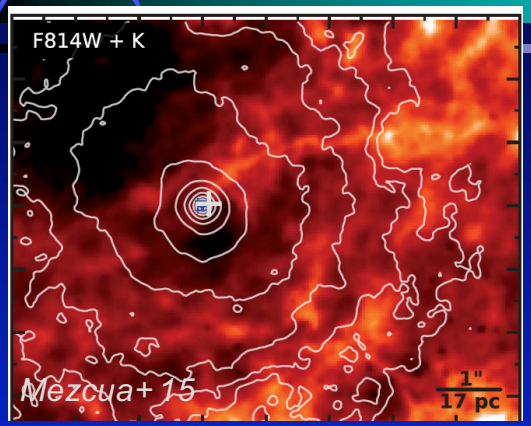

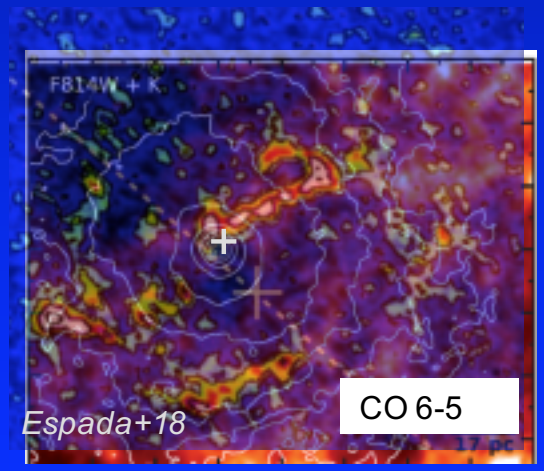

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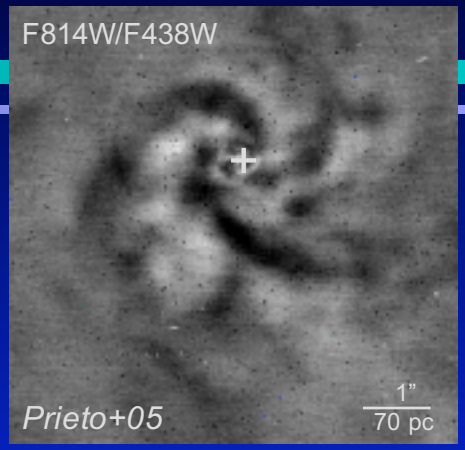

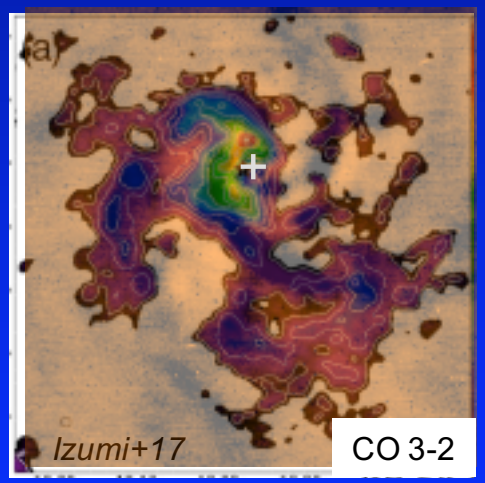

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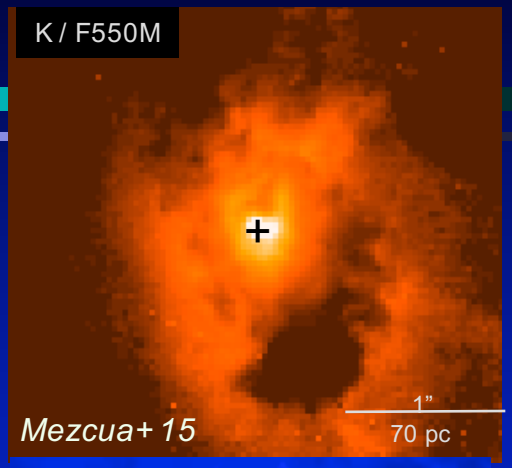

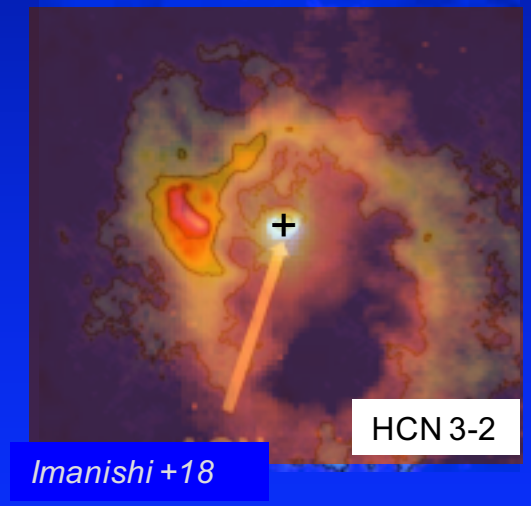

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Large scale dust filaments playing the role of the torus

- Large-scale dust filaments /lanes cross the centre of T1 and T2 sources alike
- Depending on their optical thickness, on nucleus luminosity, the nucleus is total or partially obscured
- Collimation of the ionised gas not caused by a torus: ionised gas morphology strictly defined by filaments
- Filaments run from kpc distance to the central pc: potential major suppliers for nuclear starformation and BH