Exploring structure around submm-bright QSO

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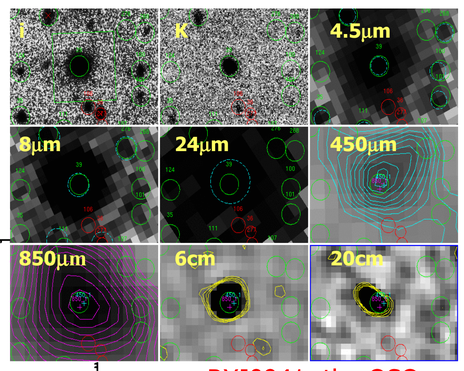
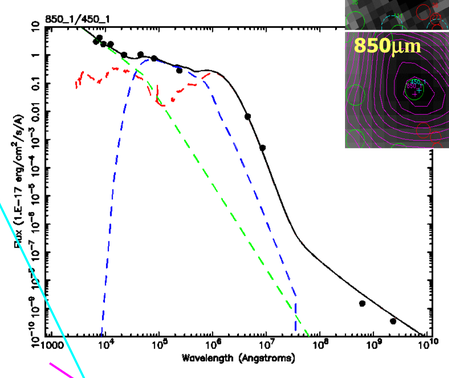
Summary: We have assembled a sample of X-ray and submm luminous QSOs which are therefore both growing their central black holes through accretion and forming stars copiously (Stevens+05). They are also surrounded by submm source overdensities (Stevens+10), placing them in the centres of high density peaks of the z~2 Universe, probably giving rise to massive ellipticals like those seen in the local Universe. We explore in detail here the field around one of those QSO: RX J0941 (z=1.82). Radio observations confirm the submm source detections and pinpoint the optical/NIR/MIR counterparts. We have used photometric redshifts and SED matching, showing that at least **4 of the 5 submm sources are associated to the QSO**, **with very little room for AGN contribution**. These are **mature galaxies with BH-to-stellar mass ratios about one dex below local values**: most of their central BH mass is still to be accreted, which can happen in a few tens of My. The **total mass is similar to that of a present-day cD galaxy** and local stellar-to-BH masses can be reached if ≤3% of the available gas mass is accreted.

Nature of the submm sources

- Stevens+10: 5 submm sources (3 in 850μm, 4 in 450μm, 2 in common)
- All detected in radio: VLA (6cm), GMRT (20cm)
  ⇒ Submm sources are real and their optical/IR counterparts can be identified
- Detecting counterparts in RiZJK+Spitzer (4.5, 8, 24μm)
- Photometric redshifts using `hyperz`, fitting Rowan-Robinson+08 (MRR08) galaxy templates to RiZJK,4.5μm,8μm
- L_{IR} and SFR from rescaling of luminosity-dependent SEDs from Chary & Elbaz (2001, CE01) to 450μm and 850μm fluxes
  - Dust mass from grey-body (Martínez-Sansigre+09)
  - Gas mass from dust mass:M_{gas}=54 M_{dust} (Kovács+06)
- Stellar mass M_* from M_K (Borys+05) calculated from best fit MRR08 template
  - log($M_*/M_\odot$)=11.5±0.2 (inc. uncertainties in z and flux)⇒Galaxies mature
  - Infered gas densities insufficient for significant further stellar growth

Source	z	L_{IR} ($10^{13}L_\odot$)	SFR ($M_\odot$/y)	M_{dust} ($10^8M_\odot$)	logM_* (log$M_\odot$)	Flux (μJy) 6cm/20cm
850_1/450_1	1.82	2.4	4100	5-22	-	194/650
850_2/450_2	1.85	2.2	3800	4-23	11.6	313/674
850_3	1.85	0.5	900	2-6	11.5	28/<96
450_3	2.8	2.1	3600	4-25	11.3	28.5/<81
450_4	1.85	1.4	2400	3-16	11.5	71.8/189



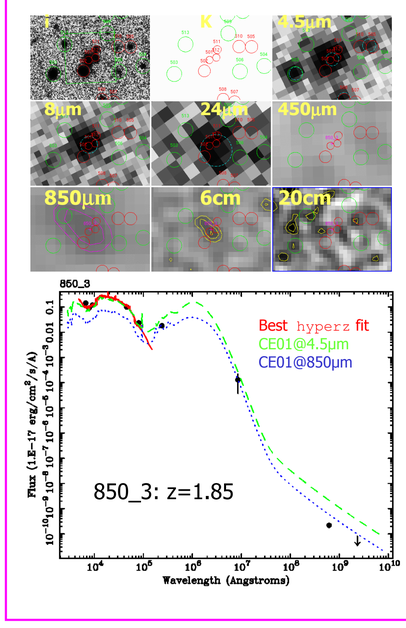


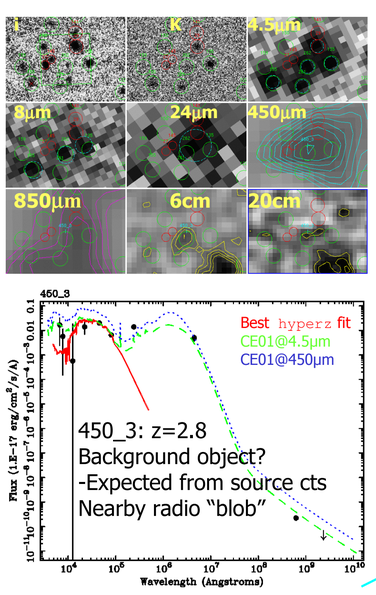
RXJ0941: the QSO

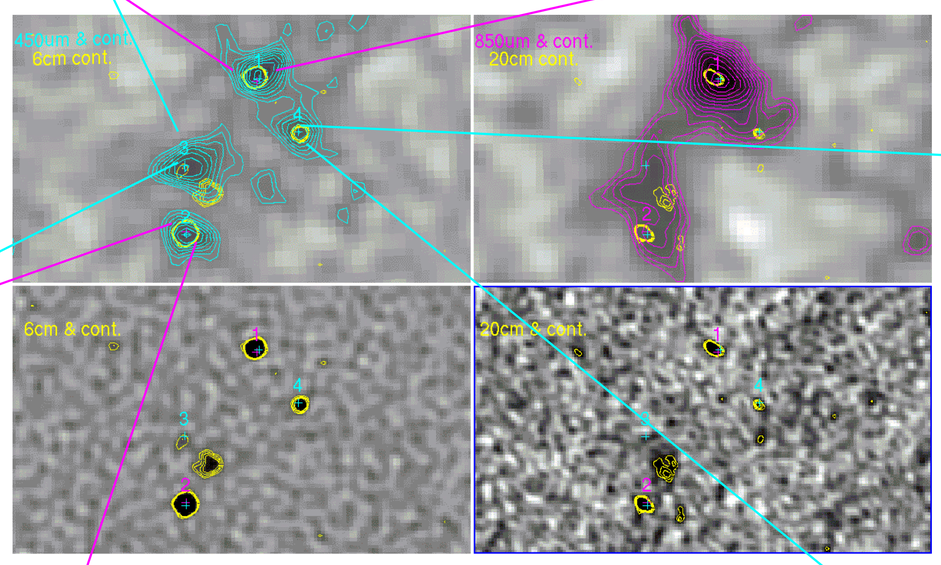
L_X=3×10^{44}erg/s (Page+10)

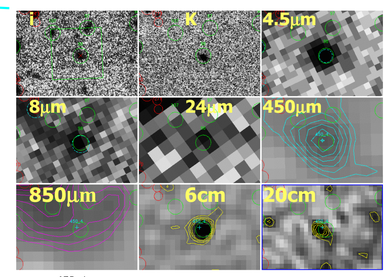
Several components:
- AGN direct accretion (MRR+08)
- AGN re-processing: torus (MRR+08)
- Star formation dominates in MIR/submm

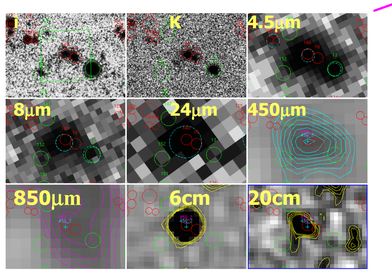
To the NW of the central region shown

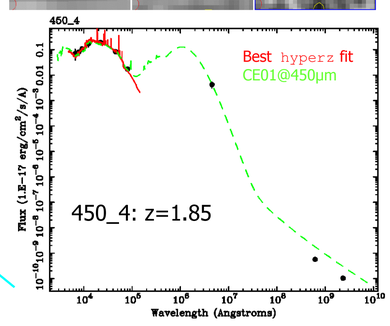


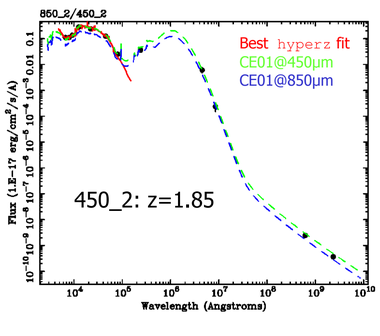






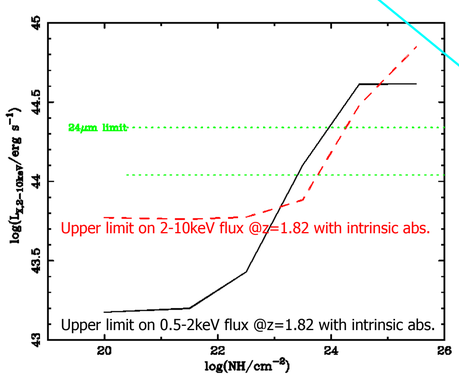






Presence of AGN

- BH masses:
  - From X-ray fluxes (Page+10, or upper limits: `FLIX`), bolometric correction (Marconi+04) and Marconi&Hunt03
  - Assuming all 24μm flux from AGN (very conservative)
- RXJ0941: detected X⇒M_{BH}~$1.3\times10^8M_\odot$
  - Getting M* from submm: expected "local" M_{BH}~$10^9M_\odot$: Undersized
- Others: up. lims. ⇒M_{BH}<$1.3\times10^8M_\odot$
  - Expected "local" M_{BH}~$10^9M_\odot$: Undersized



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