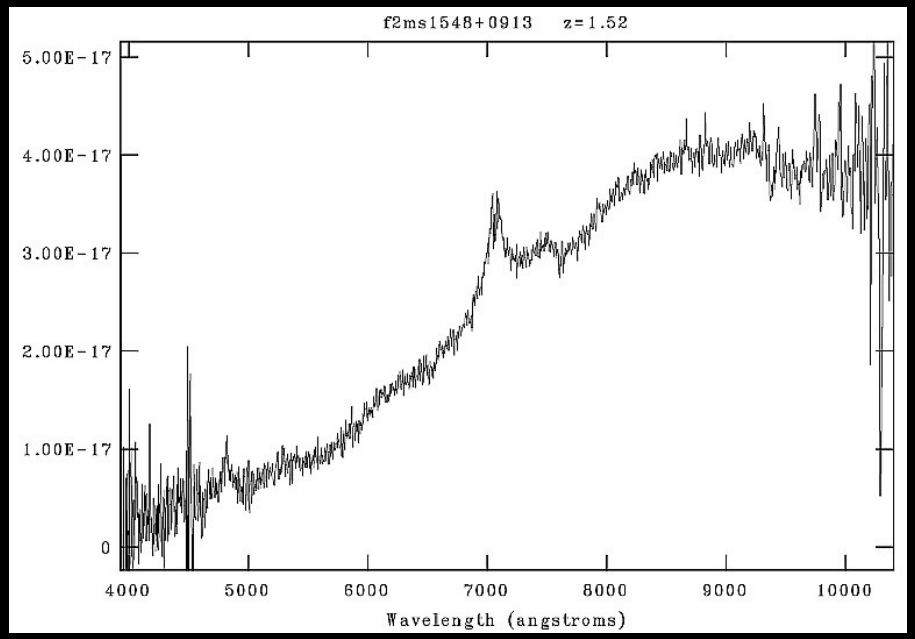
Evidence of Mergers in Dust-Obscured Type 1 Quasars

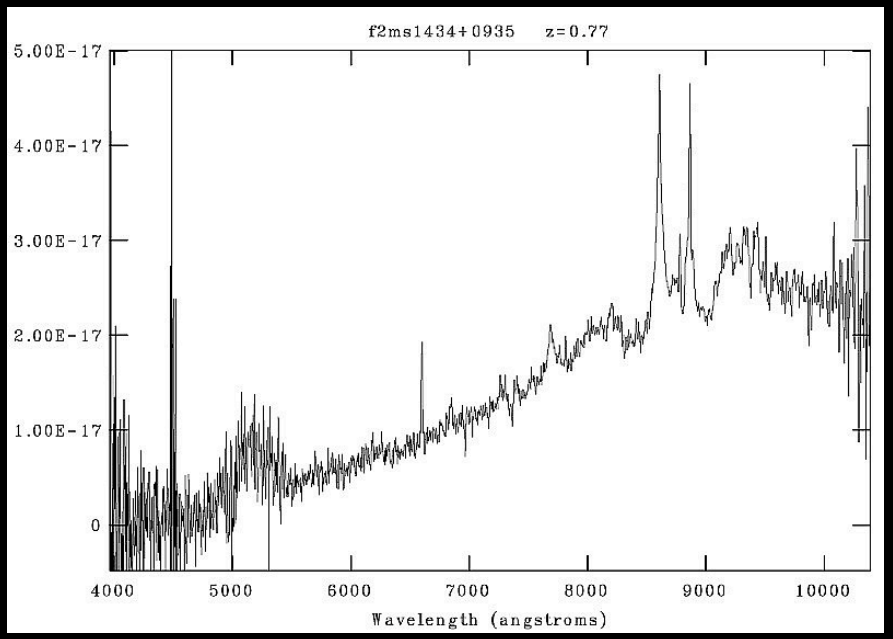
Tanya Urrutia

UC Davis – IGPP LLNL

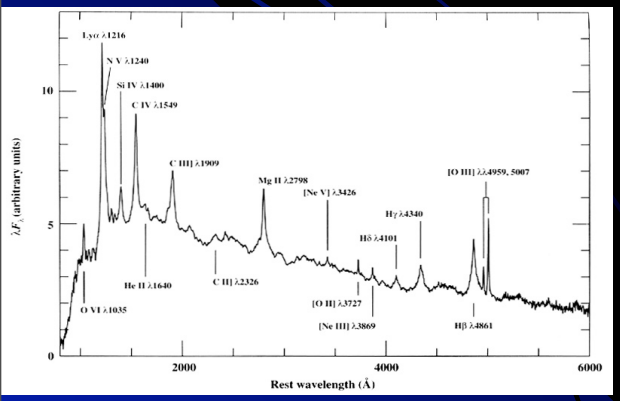
Collaborators: "The One True Bob" Becker, Mark Lacy, Eilat Glikman, Rick White, Michael Gregg, David Helfand, Gaby Canalizo…

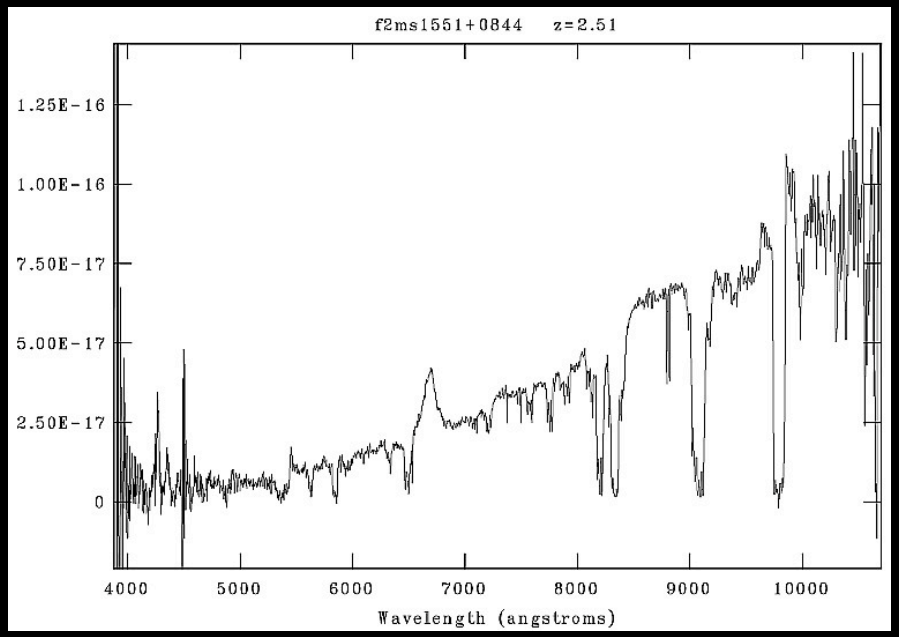
Red Quasars – Type 1 Obscured Quasars





White et al. (2003), Glikman et al. (2004, 2007), Urrutia et al., in preparation…





X-ray follow-up

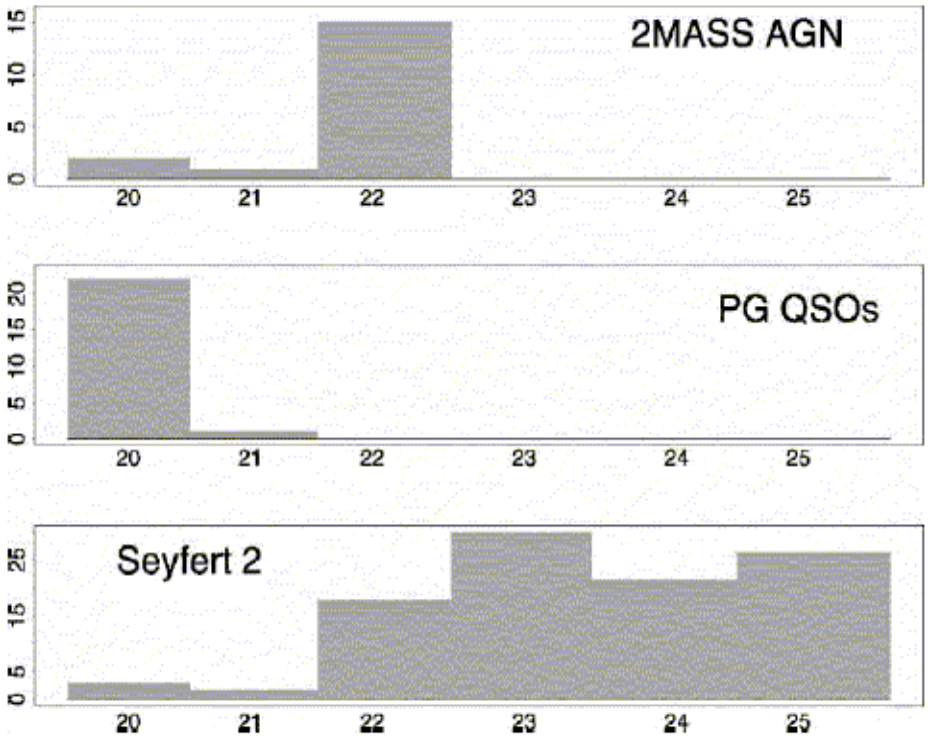


FIG. 2.—Distribution of the logarithm of the equivalent neutral hydrogen absorption column densities, N_H, derived from the X-ray HRs for the 2MASS AGNs, assuming a power-law spectrum with $\alpha_E = 1.0$ and absorption intrinsic to the AGNs, compared with those of optically selected PG QSOs (Laor et al. 1997) and Seyfert 2 galaxies (Risaliti et al. 1999).

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

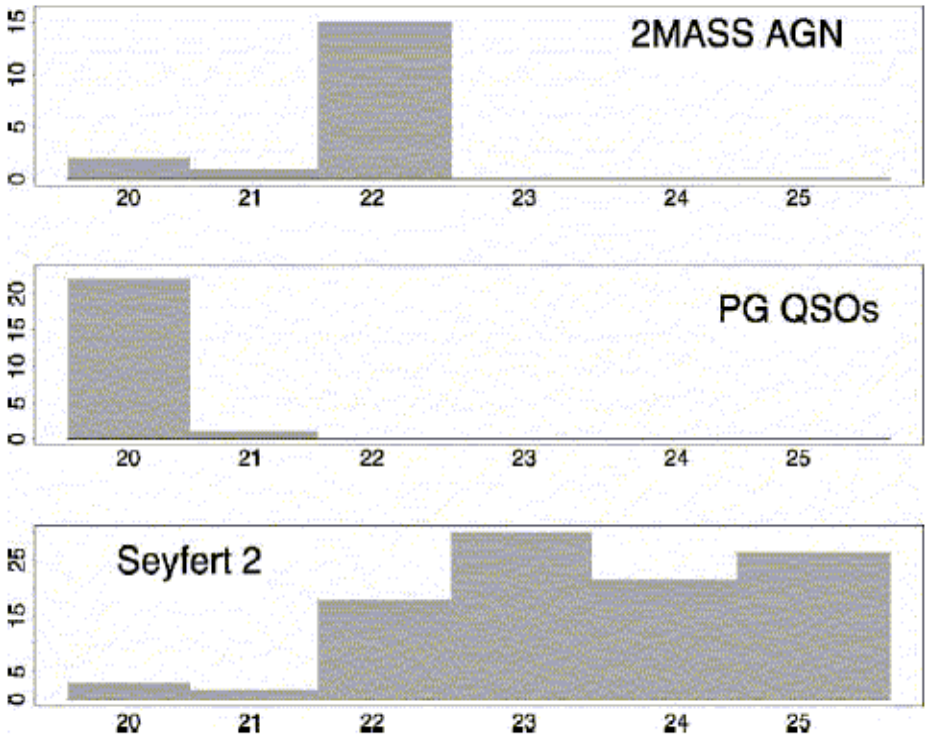


FIG. 2.—Distribution of the logarithm of the equivalent neutral hydrogen absorption column densities, N_H, derived from the X-ray HRs for the 2MASS AGNs, assuming a power-law spectrum with $\alpha_E = 1.0$ and absorption intrinsic to the AGNs, compared with those of optically selected PG QSOs (Laor et al. 1997) and Seyfert 2 galaxies (Risaliti et al. 1999).

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

  ~ 2.5 x 10^{22} cm^{-2}

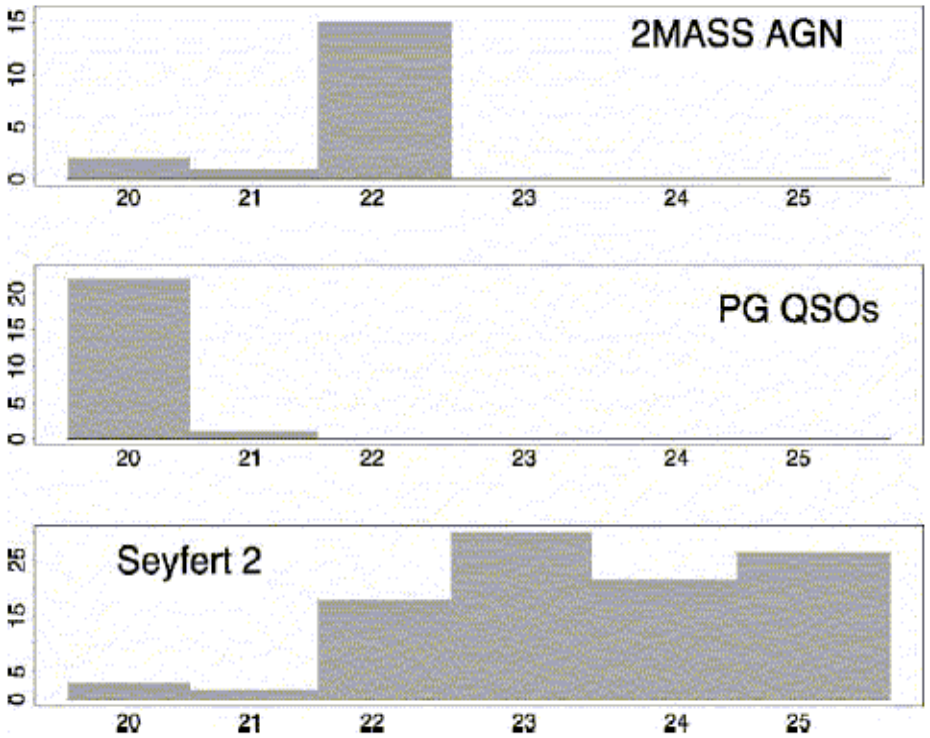


FIG. 2.—Distribution of the logarithm of the equivalent neutral hydrogen absorption column densities, N_H, derived from the X-ray HRs for the 2MASS AGNs, assuming a power-law spectrum with $\alpha_E = 1.0$ and absorption intrinsic to the AGNs, compared with those of optically selected PG QSOs (Laor et al. 1997) and Seyfert 2 galaxies (Risaliti et al. 1999).

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

  ~ 2.5 x 10^{22} cm^{-2}
- Wide range of dust:gas ratios (1-25 times Galactic value).

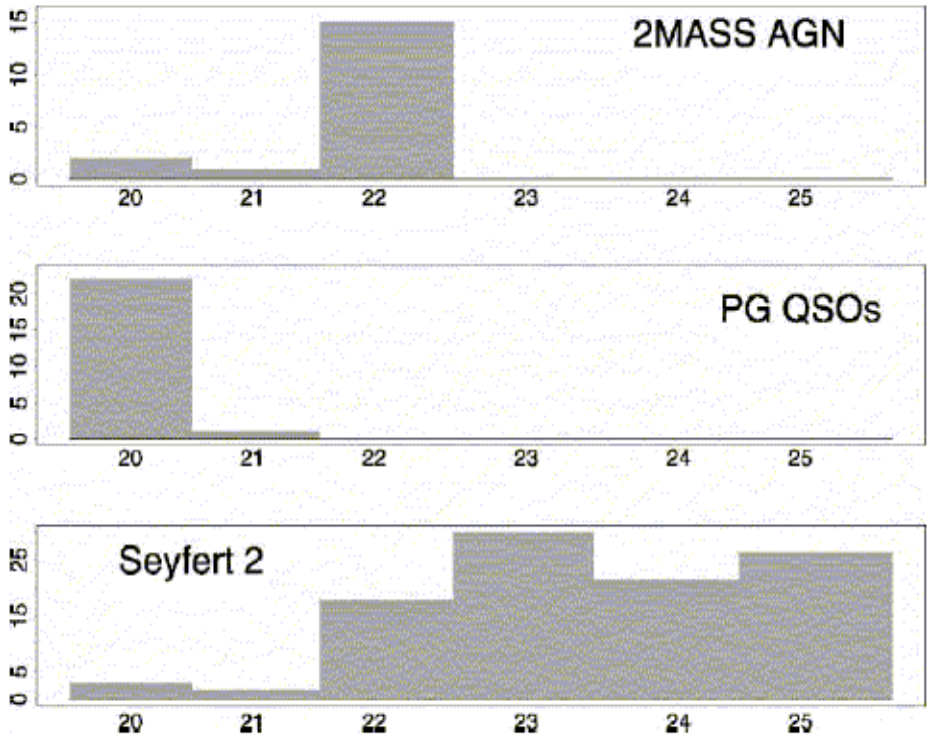


FIG. 2.—Distribution of the logarithm of the equivalent neutral hydrogen absorption column densities, N_H, derived from the X-ray HRs for the 2MASS AGNs, assuming a power-law spectrum with $\alpha_E = 1.0$ and absorption intrinsic to the AGNs, compared with those of optically selected PG QSOs (Laor et al. 1997) and Seyfert 2 galaxies (Risaliti et al. 1999).

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

  ~ 2.5 x 10^{22} cm^{-2}
- Wide range of dust:gas ratios (1-25 times Galactic value).
- Our red QSOs have higher than normal spectral slopes (mean

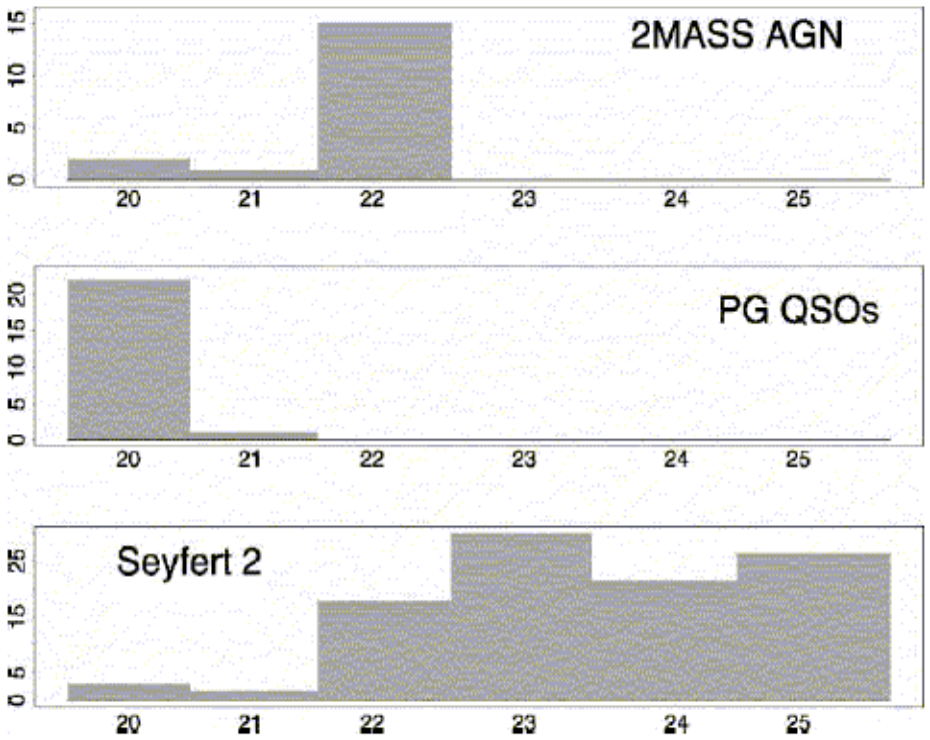


FIG. 2.—Distribution of the logarithm of the equivalent neutral hydrogen absorption column densities, N_H, derived from the X-ray HRs for the 2MASS AGNs, assuming a power-law spectrum with $\alpha_E = 1.0$ and absorption intrinsic to the AGNs, compared with those of optically selected PG QSOs (Laor et al. 1997) and Seyfert 2 galaxies (Risaliti et al. 1999).

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

  ~ 2.5 x 10^{22} cm^{-2}
- Wide range of dust:gas ratios (1-25 times Galactic value).
- Our red QSOs have higher than normal spectral slopes (mean

  Γ ~ 2.25 compared to 1.8 of normal QSOs).

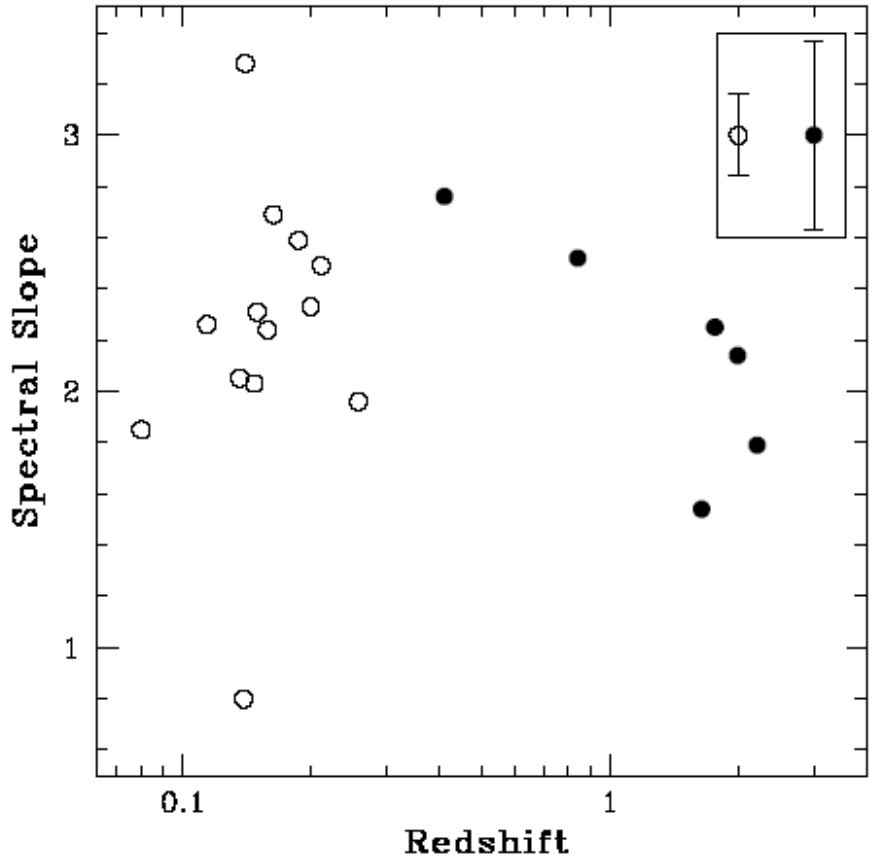


Fig. 3.— Spectral slopes vs. redshift. Filled dots are from our sample, open dots are from Wilkes' low redshift red AGN sample. The box shows the errors of the points in the sample.

Wilkes et al. (2002), Urrutia et al. (2005)

X-ray follow-up

- X-rays deduced column densities

  ~ 2.5 x 10^{22} cm^{-2}
- Wide range of dust:gas ratios (1-25 times Galactic value).
- Our red QSOs have higher than normal spectral slopes (mean

  Γ ~ 2.25 compared to 1.8 of normal QSOs).
- Higher spectral slopes might mean higher accretion rate than normal AGN.

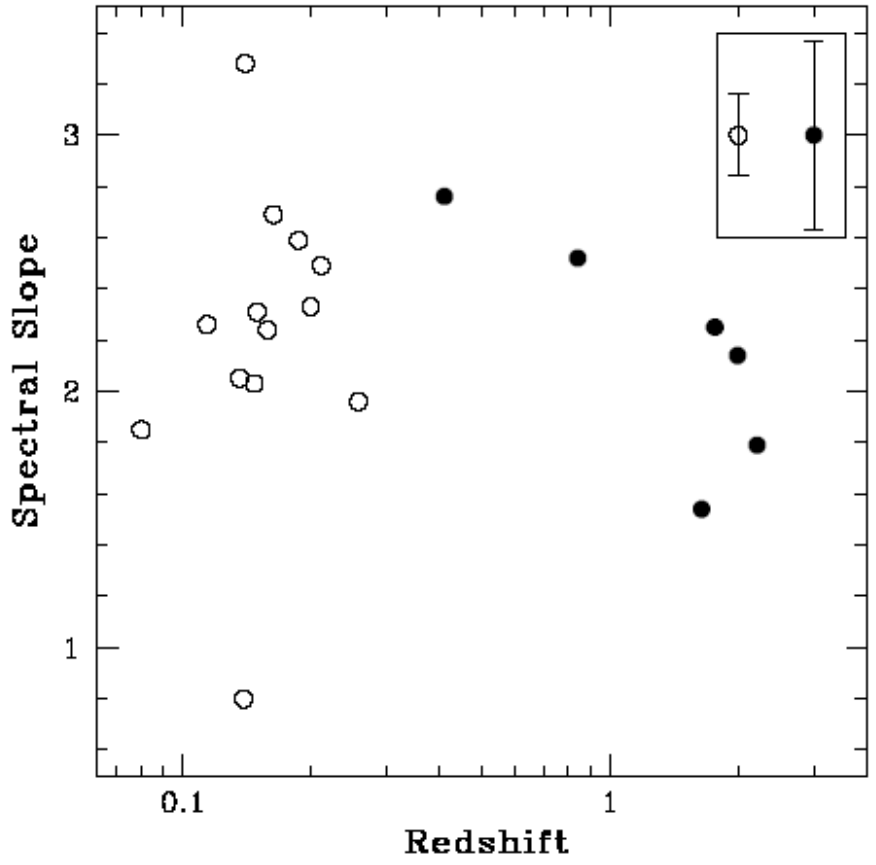
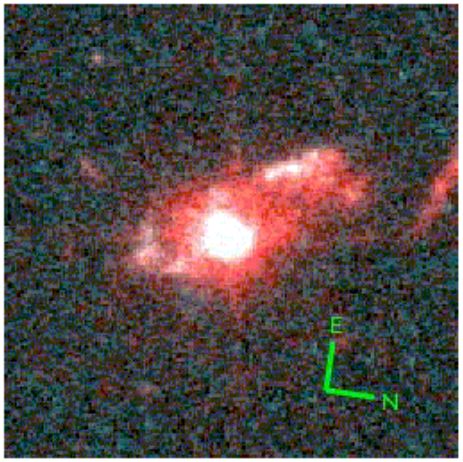


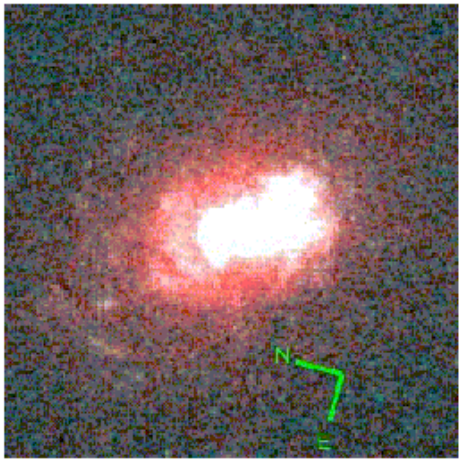
Fig. 3.— Spectral slopes vs. redshift. Filled dots are from our sample, open dots are from Wilkes' low redshift red AGN sample. The box shows the errors of the points in the sample.

Wilkes et al. (2002), Urrutia et al. (2005)

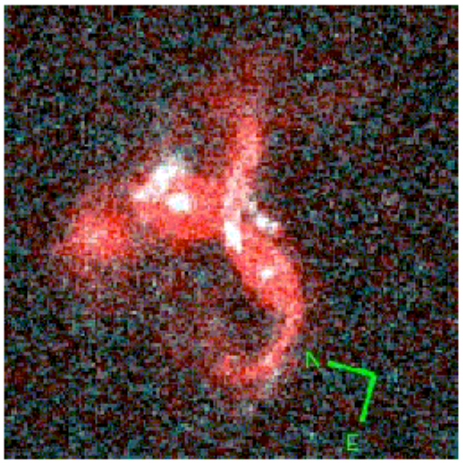
Hubble Images of 13 Red Quasars



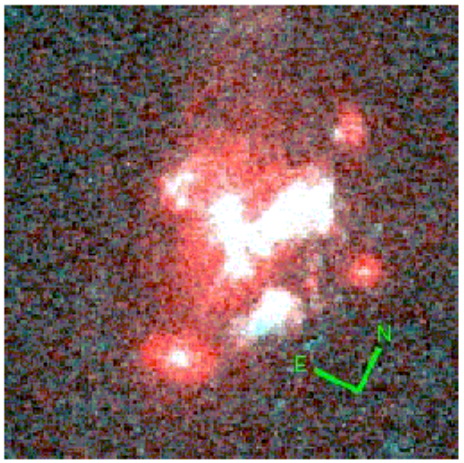
F2M0729+3336, z = 0.937



F2M0830+3759, z = 0.413



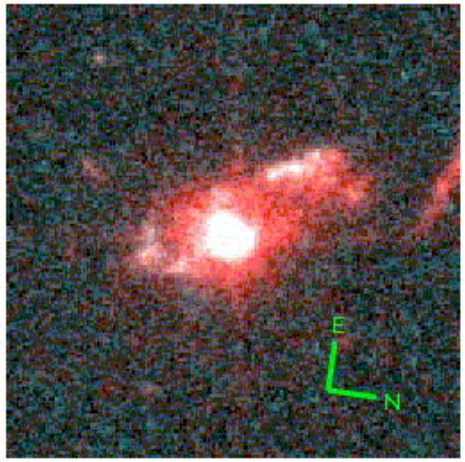
F2M0841+3604, z = 0.552



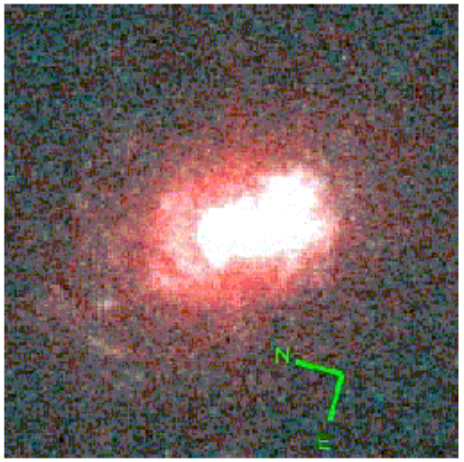
F2M1532+2415, z = 0.564

Urrutia et al. (2007), submitted

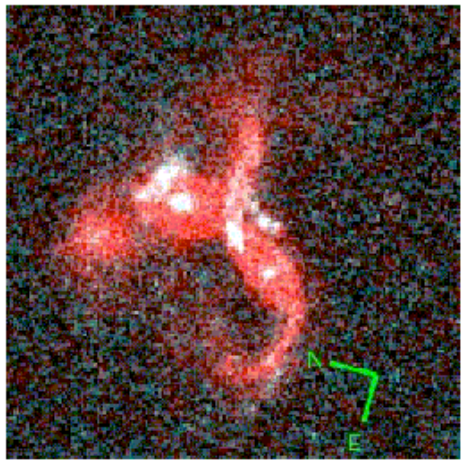
Hubble Images of 13 Red Quasars



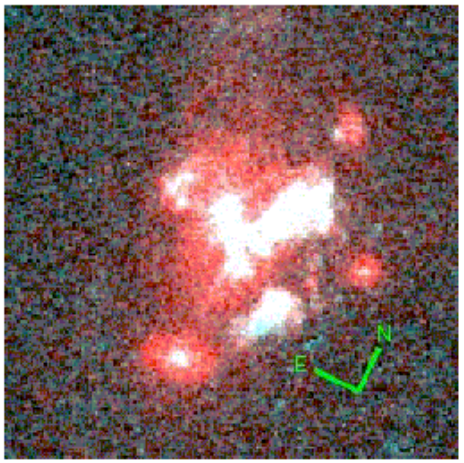
F2M0729+3336, z = 0.937



F2M0830+3759, z = 0.413



F2M0841+3604, z = 0.552

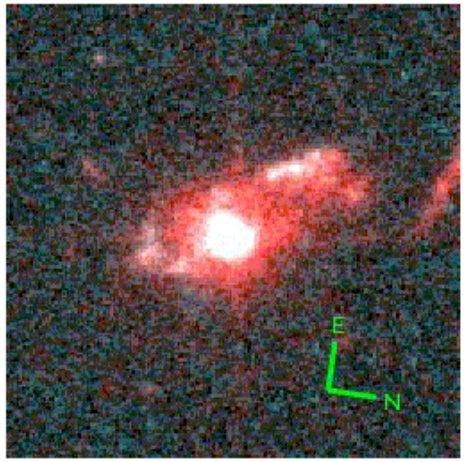


F2M1532+2415, z = 0.564

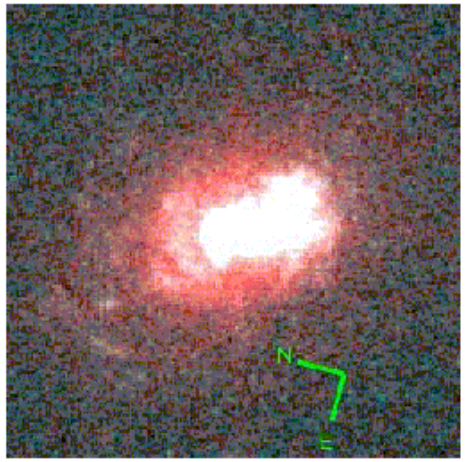
- Only 2 host galaxies don't show obvious merger, none fit a perfect elliptical profile (usually 40%-60%)

Urrutia et al. (2007), submitted

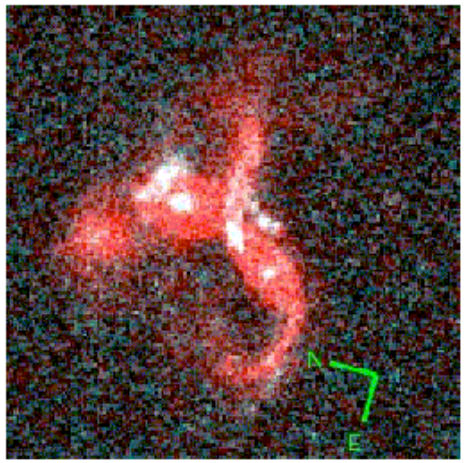
Hubble Images of 13 Red Quasars



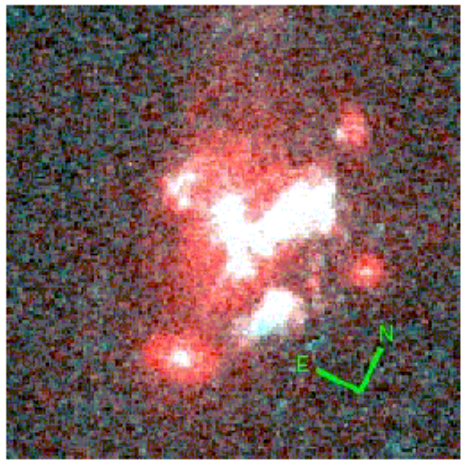
F2M0729+3336, z = 0.937



F2M0830+3759, z = 0.413



F2M0841+3604, z = 0.552

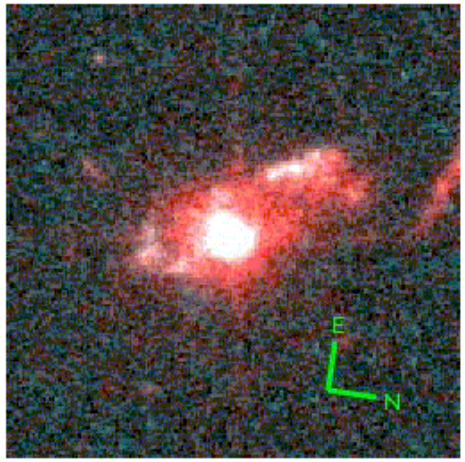


F2M1532+2415, z = 0.564

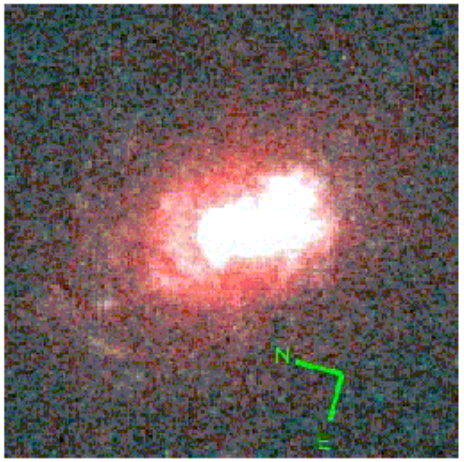
- Only 2 host galaxies don't show obvious merger, none fit a perfect elliptical profile (usually 40%-60%)
- When doing PSF subtraction, the quasar colors are even redder. Most of the blue light is from the host galaxy

Urrutia et al. (2007), submitted

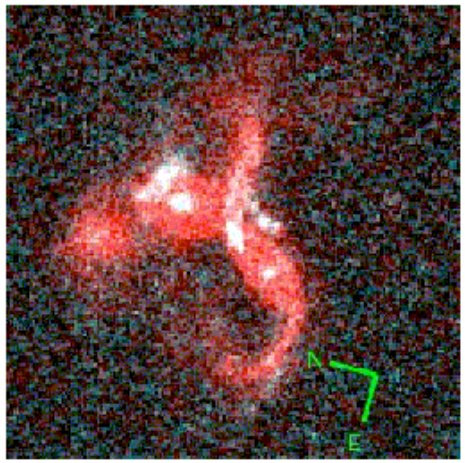
Hubble Images of 13 Red Quasars



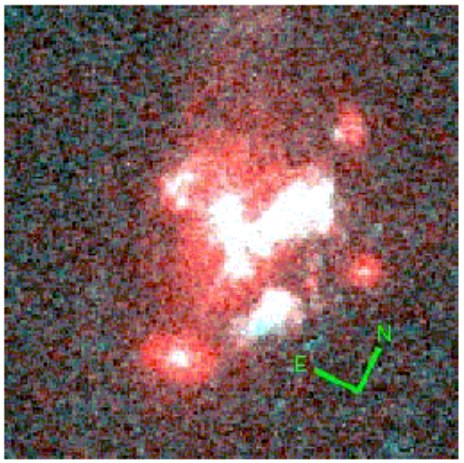
F2M0729+3336, z = 0.937



F2M0830+3759, z = 0.413



F2M0841+3604, z = 0.552

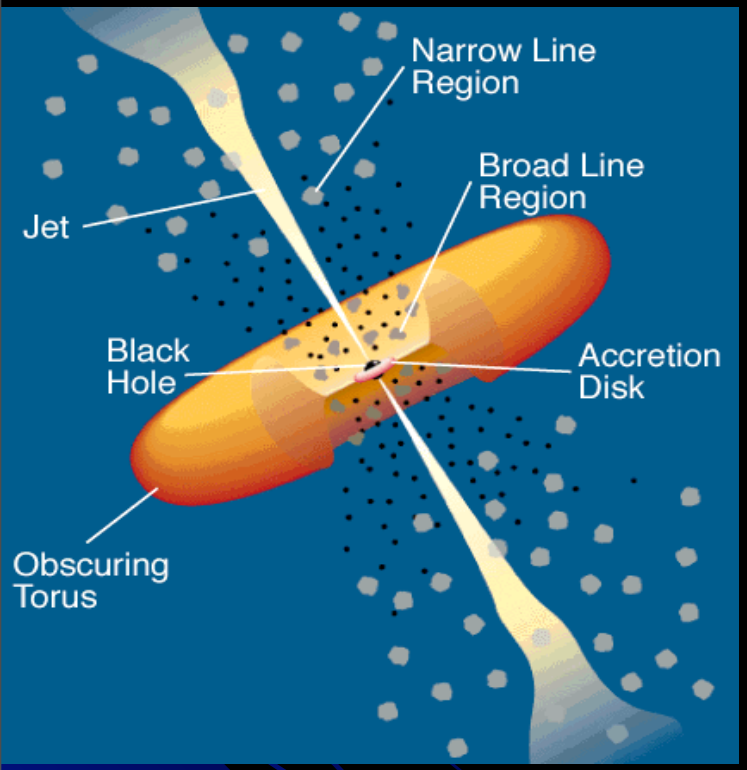


F2M1532+2415, z = 0.564

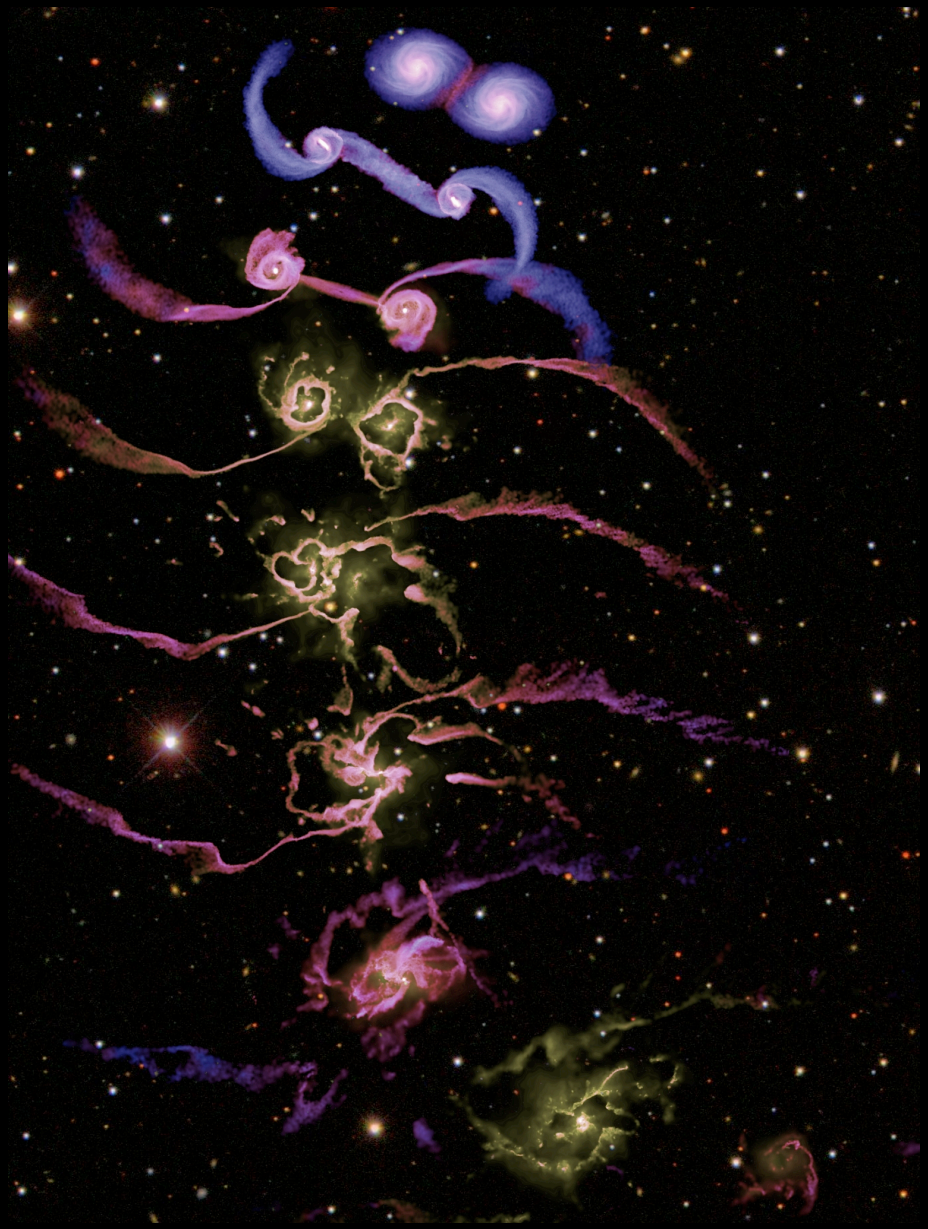
- Only 2 host galaxies don't show obvious merger, none fit a perfect elliptical profile (usually 40%-60%)
- When doing PSF subtraction, the quasar colors are even redder. Most of the blue light is from the host galaxy
- Dust reddening – merger amount is correlated (Gini coefficient).

Urrutia et al. (2007), submitted

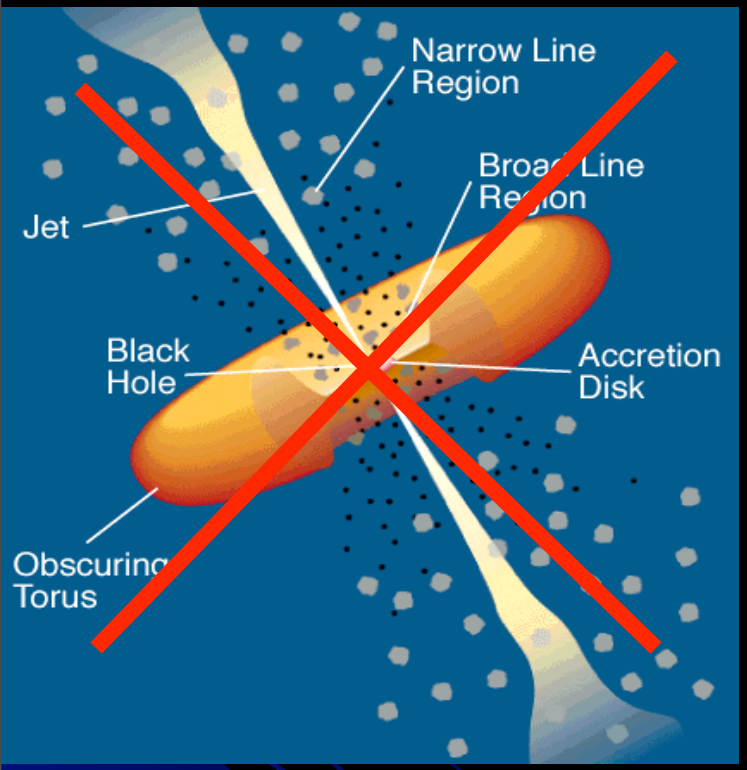
Type I / Type II



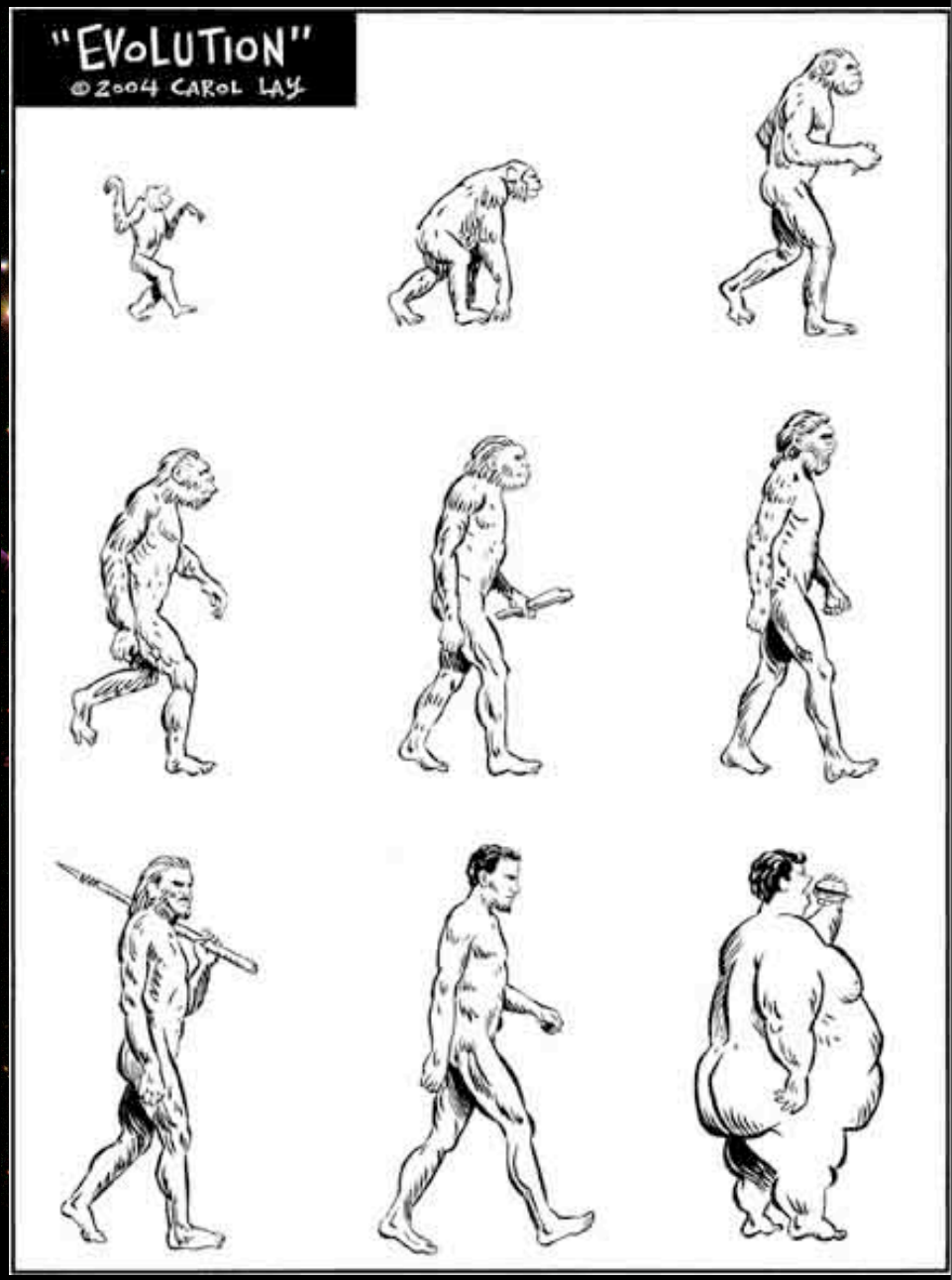
vs.



Type I / Type II



vs.



Red quasars could be an evolutionary stage during the merger of galaxies. The dust of the galaxies is still settling in!

Summary & Outlook

- Color surveys are biased to finding blue unobscured QSOs, we might be missing a large population
- New targeted surveys are finding significant numbers of Type 1 dust reddened quasars
- In the X-rays red quasars are moderately absorbed ($10^{22}cm^{-2}$), yet their gas:dust ratio is more typical of galactic values. ISM doing obscuration?
- Red quasars might be an evolutionary stage in the life of an AGN. Hubble images support that hypothesis.
- Future: radio observations, AO LGS imaging, Spitzer (finally got time), …
- Open questions: definite fraction…

urrutia@physics.ucdavis.edu