X−ray observations of submm−faint, z~2 radio sources

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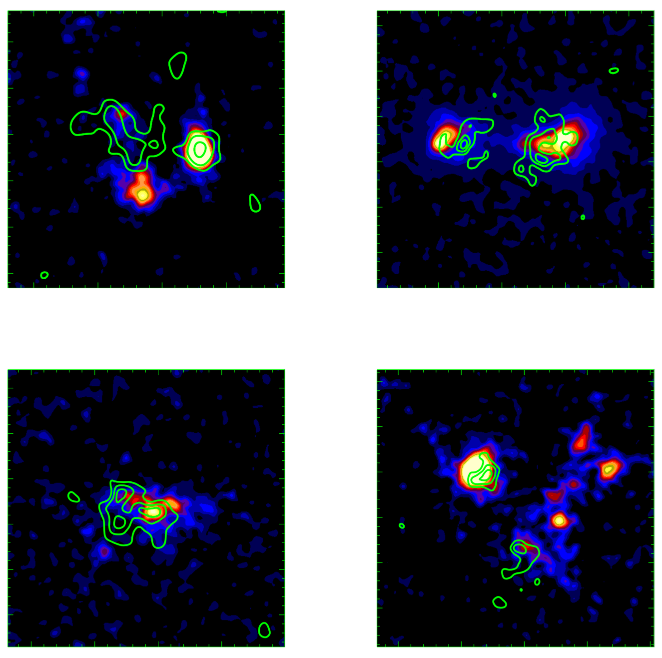
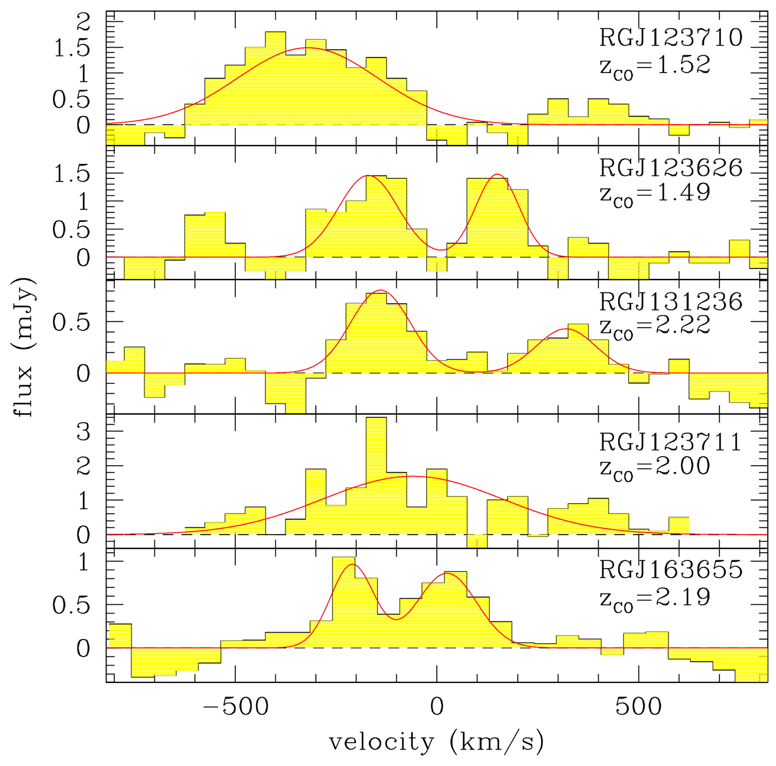
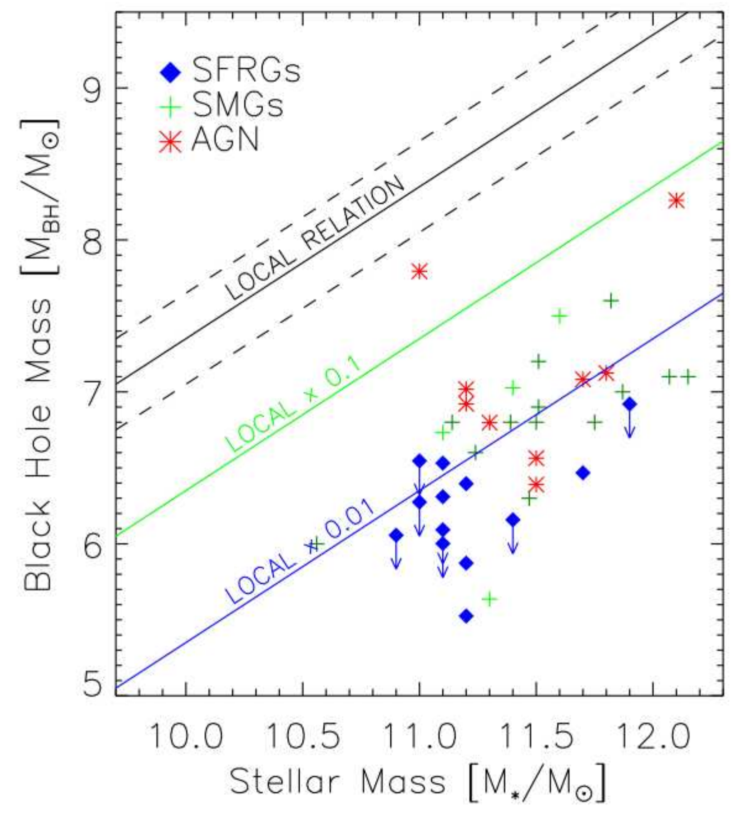
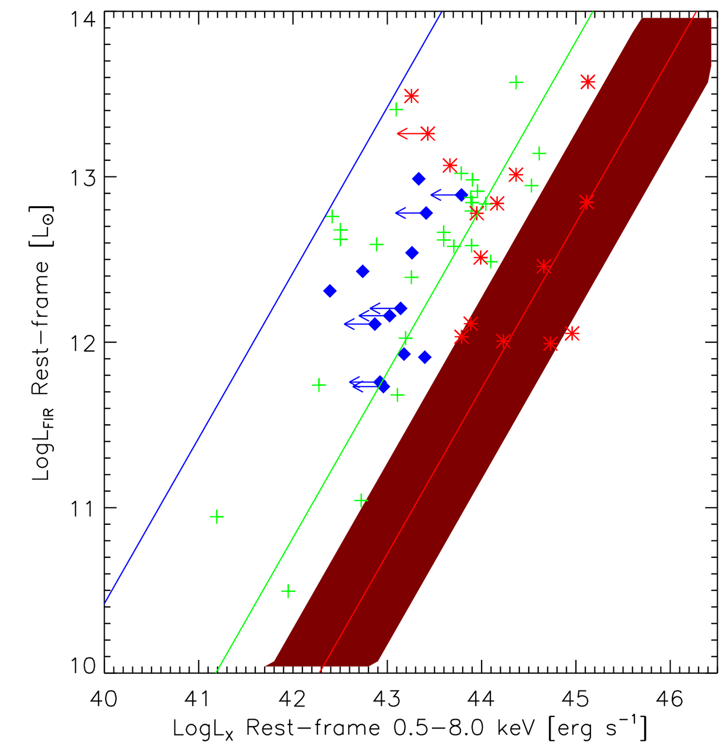


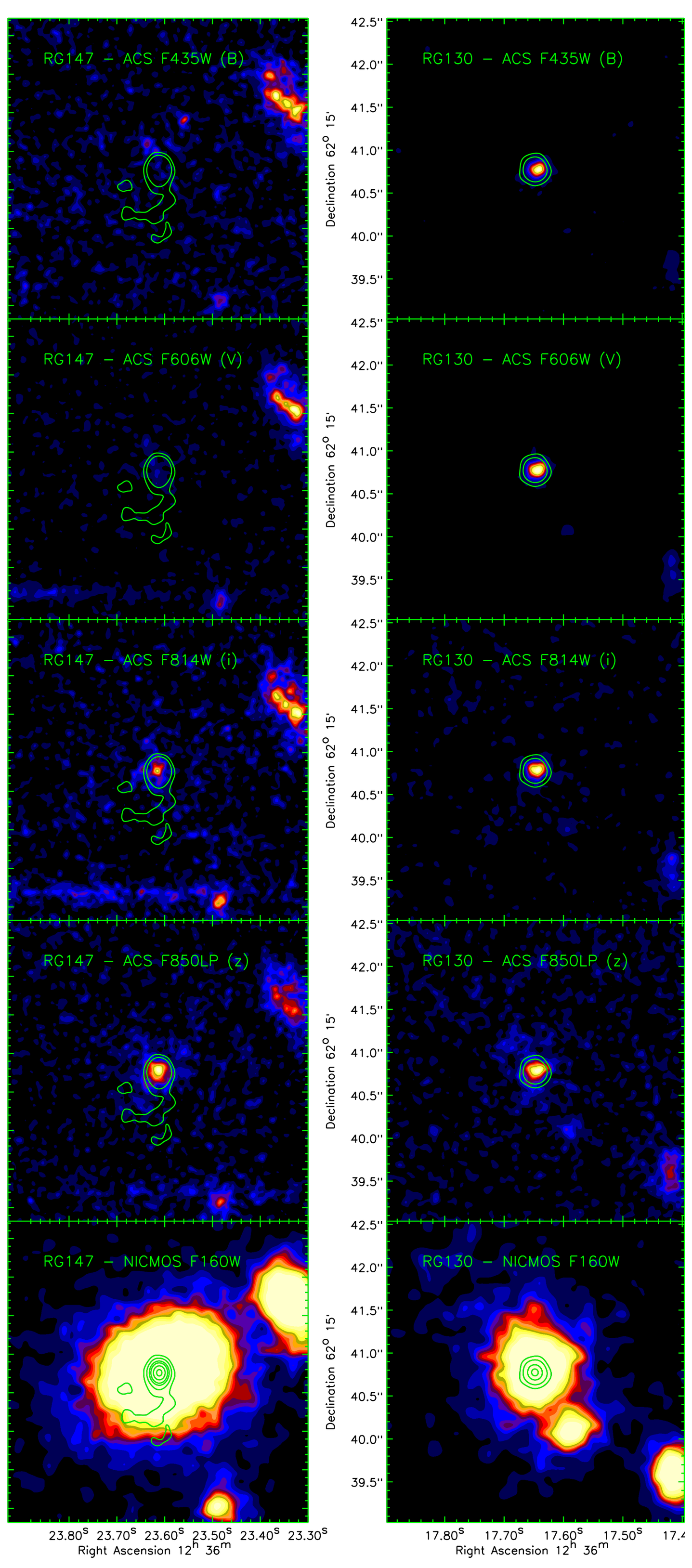


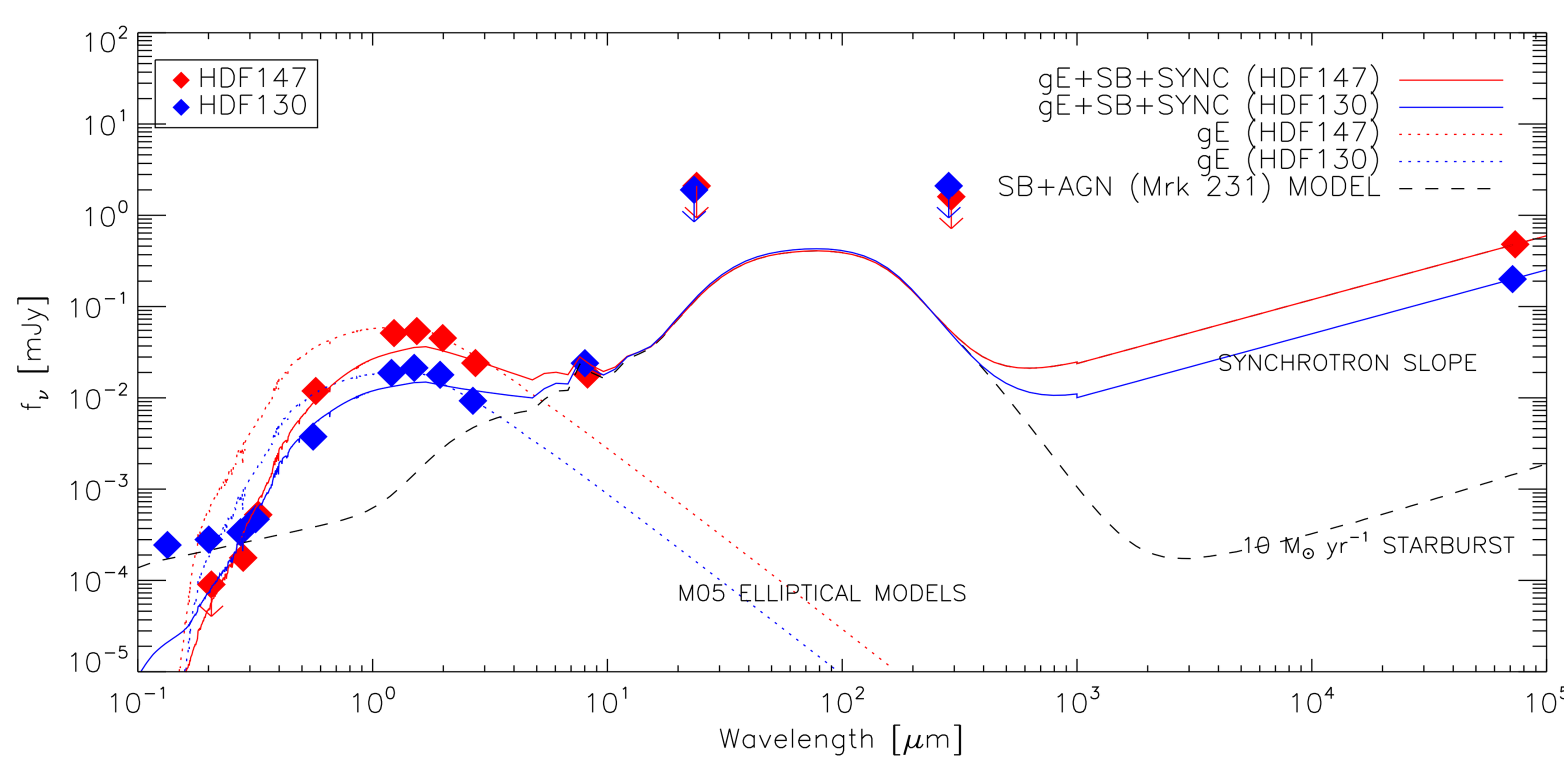
A subset of the optically faint radio galaxies (OFRGs) at z~2 have now been confirmed to be powered by star formation (star forming radio galaxies − SFRGs). New high resolution MERLIN radio observations (left panel − radio contours superposed on HST/ACS i−band imaging) and IRAM molecular gas observations (righ panel − CO3−2 or CO2−1 rotational transitions) confirm this population is similar to the ultraluminous Submillimetre Galaxies (SMGs), but having slightly hotter dust temperatures. The resulting lower submm fluxes mean these galaxies have gone largely unrecognized previously. The volume density of this new 'hot' population means they contribute to the star formation rate density at z~2 similarly to the SMGs.
(All figures shown in the line above are from Casey et al. (2008, in preparation).

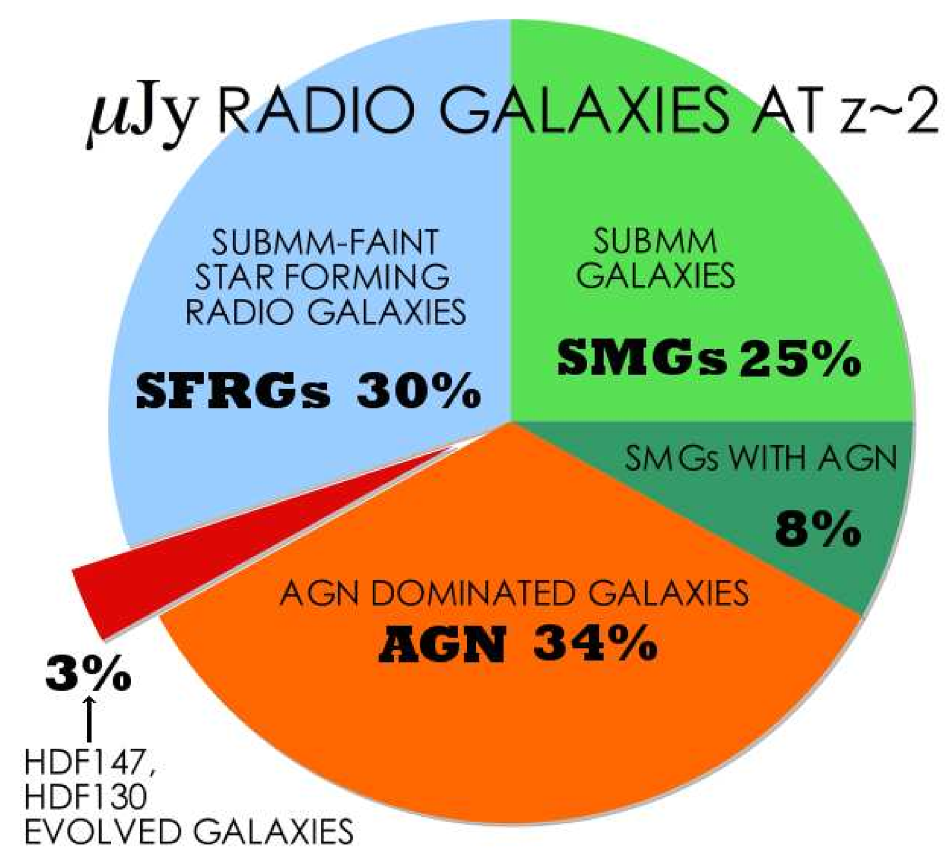




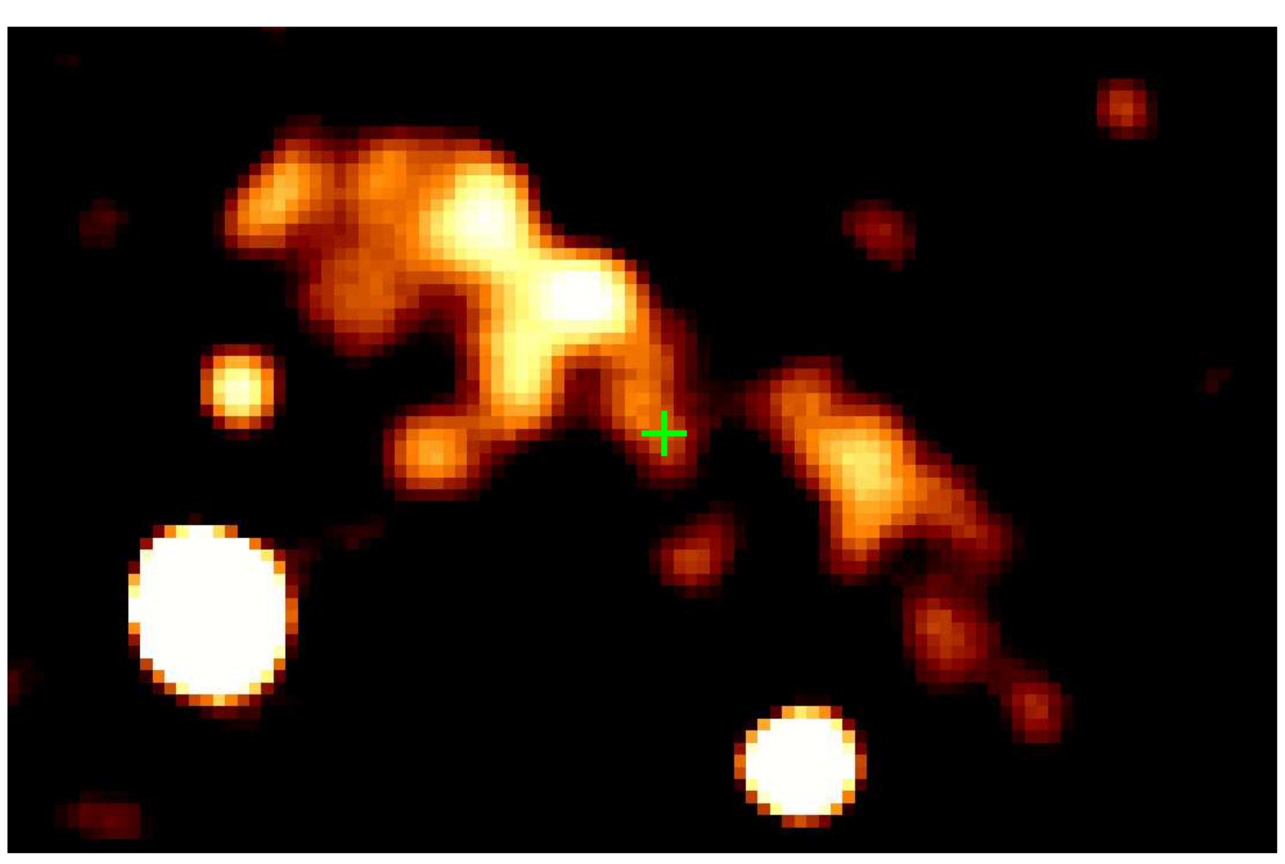
The relation between stellar and SMBH masses for our samples of SFRGs, SMGs, and radio sources at z~2 dominated by AGN (left panel: all sources lie in the GOODS−N field). Black hole masses are derived using the assumption of Eddington−limited accretion. Stellar masses are derived by using Spitzer−IRAC derived rest−frame K−band magnitudes, and assuming L/M=3.2. The upper line and dashed line envelope denote the best fit to local galaxies derived by Marconi & Hunt (2003, ApJ, 589, L21). The lower dashed lines denote tracks with BH masses a tenth and hundredth of the local relation. The right panel shows the far−IR versus X−ray luminosity diagram, modeled after Alexander et al. (2005, AJ, 632, 736).Bothe SFRGs and SMGs lie well outside the band of AGN−dominated far−IR sources. Both plots above reveal that SFRGs are somewhat lower in Xray luminosity than SMGs, and may indicate the SMBHs have different masses or accretion efficiencies from SMGs.

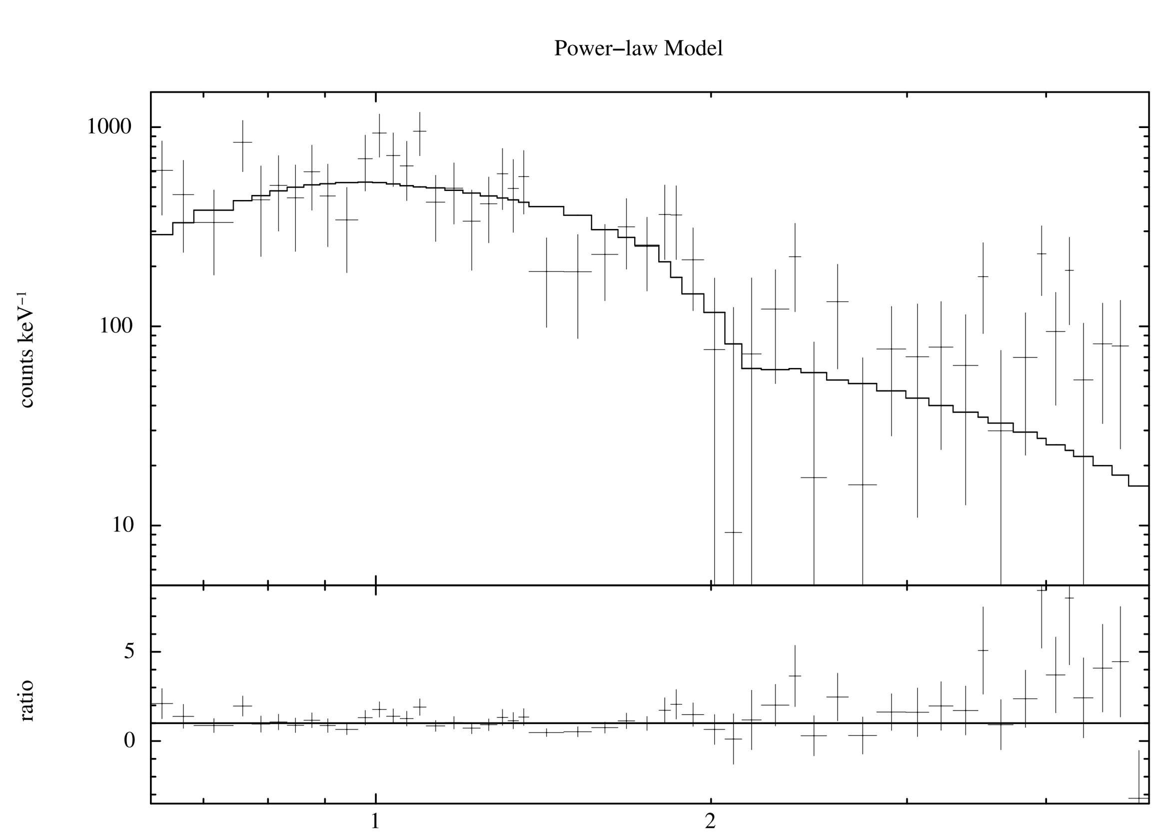


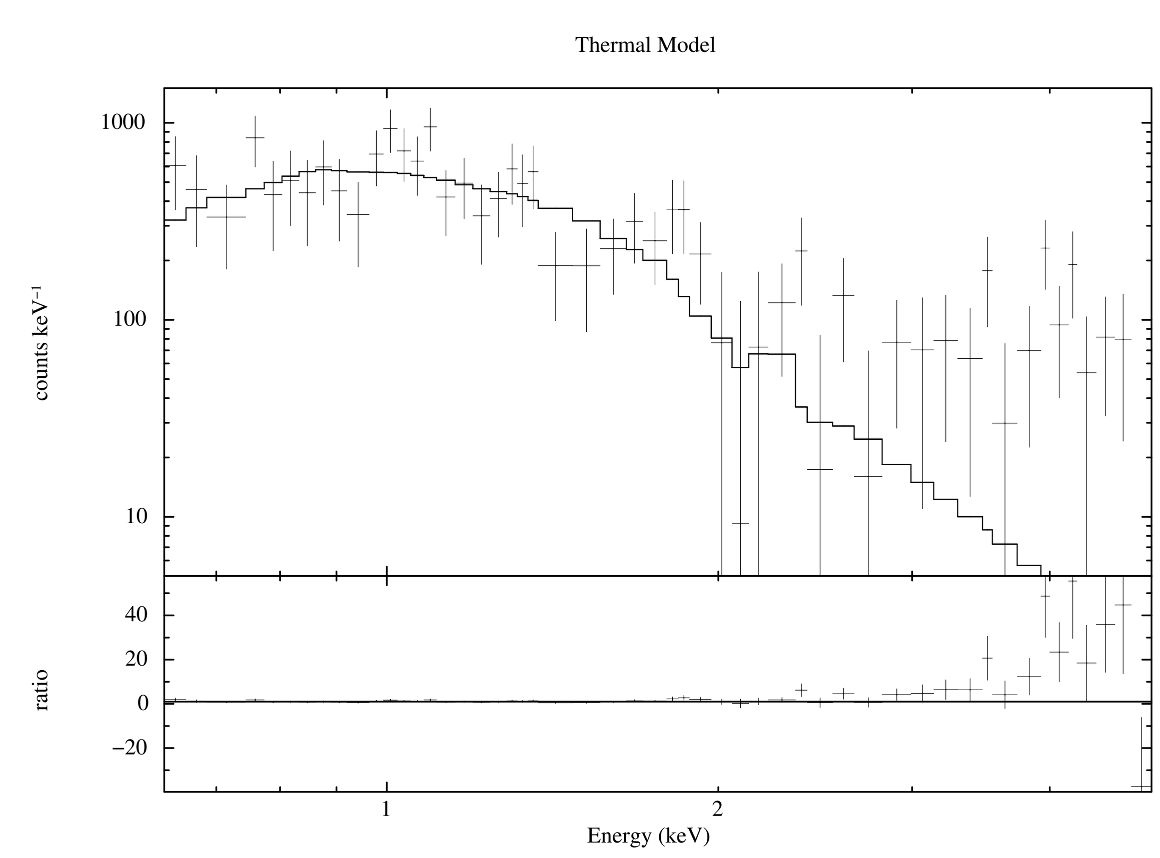




(left panel) HDF147 and HDF130 are radio sources selected from a sample of optically faint radio galaxies (OFRGs − Chapman et al. 2004, ApJ, 614, 671). Although they have starburst classifications from UV−spectroscopy, as well as weak X−ray (undetected in 2Msec Chandra) and weak 24 micron Spitzer (~0.020 mJy), the compact MERLIN radio observations demand that these sources are AGN (using maximal starburst arguments). While their radio scale sizes are <500 pc, their rest−frame optical morphologies reveal large Elliptical−like galaxies (~12 kpc across), comparable to local Elliptical galaxies. (middle panel) Modeling their rest−frame K−band emission suggests the galaxies are dominated by old, evolved stellar populations.
(right panel) A pie chart describing the demographics of z~2 radio sources suggests HDF147 and HDF130 represent a small but significant fraction of radio sources which can be easily mis−classified as starbursts without detailed analysis and high spatial resolution radio observations. (All figures from Casey et al. 2008, MNRAS, in press : see http://ast.cam.ac.uk/~ccasey/sfrg.html for details).







(From Fabian et al. 2008, in preparation): In the left panel we show the extended X−ray source in the 2Msec CDFX (Bauer et al. 2002 AJ, 123, 1163), for which they were unable to find a couterpart in the optical. We show as a green cross the position of the OFRG HDF130 above, which we hypothesize must be the source of this extended X−ray emission. Atz~2, the Xray emission would span several hundred kpc. From energetic and spectroscopic arguments in the Xray, we suggest that the extended source represents Inverse−Compton scattering. Assuming equipartition in the radio plasma, the energy density in the CMB at z=2 can account for the observed X−ray luminosity. Power law and Thermal fits are shown in the middle and right panels. The Compton cooling time is ~50 Myr.