CONTINUOUS UV-IR SPECTRAL ENERGY DISTRIBUTIONS OF QUASARS

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ABSTRACT. In the present research, we propose continuous UV to IR SED templates of quasars derived from the AGN torus emission. The IR emission of the active nucleus is extracted from observations of distant 3CR radio galaxies after subtraction of their star, gas and dust galaxy components with our galaxy model. This IR emission continues in the far-UV to optical emission with the help of a classical model of AGN from Selsing et al, 2016. The galaxy templates are from the evolution code Pégase.3 by Fioc and Rocca-Volmerange, 2019 and the AGN clumpy dust models from Siebenmorgen et al, 2015. The final UV-IR templates of quasars, depending on z and inclination, will be tools to interpret magnitudes and colors of galaxies and quasars at various redshifts, the physical link of the star formation-AGN activities as the contribution of the IGM with Gaia, ALMA, SPITZER and the future telescopes JWST, EUCLID and others (work in progress).
Keywords: Galaxies (quasars): general, torus, infrared: galaxies, ISM: dust, emission

1. THE AGN TORUS FROM DUST MODELS

Multiwavelength hybrid spectral energy distributions SEDs (Drouart et al., 2016) are built to follow the evolution of distant radiogalaxies with the host galaxy and an evolving starburst of the code Pégase3 (Fioc &Rocca-Volmerange, 2019, www2.iap.fr/pegase) plus a clumpy AGN torus model from Siebenmorgen et al., 2015. Pégase3 predicts from 0 to 20 Gyrs, the stellar and nebular emissions, corrected for metallicity-dependent dust attenuation, updated from Fioc &Rocca-Volmerange, 1997, and coherently extended by radiative transfer MonteCarlo simulations to the IR dust emission, respecting the energy balance The best-fit procedures are testing these multiple synthetic libraries on UV-to-far-IR observations of 3CR galaxies. An example of the decomposition (Fig.1) for the radiogalaxy 3C356 identifies three components: the AGN torus in the midIR (green line), the evolved galaxy component (orange line) and the young starburst (blue line). The synthetic global sum is the light black line. The references are given for other 3CR radiogalaxies including 3C266 (Drouart et al.,2016, Podigachoski et al., 2016, see also Fig.3) applying the hybrid method to the 3CR catalog at various z. Three components (AGN, old galaxy and evolved starburst) are found in all cases, even at higher redshifts.

2. THE UV-IR QUASAR TEMPLATES

Selsing et al. 2016 extracts the ultraviolet-blue to near-IR composite spectrum of quasars from various QSO samples, observed at different epochs with different instruments, in particular on selected observations at $1 \leq z \leq 2.1$ from the Sloan Digital Sky Survey (SDSS). After subtractions of X-ray attenuation and the galaxy host contribution, a power-law continuum for the composite spectrum on the rest-frame range from Lyβ to 11350$\AA$ is proposed. The continuum of a single quasar spectrum is then modeled as a power law, $f_\lambda = A\ \lambda^{\alpha(\lambda)}$ with a spectral slope of $\alpha = 1.70\lambda \pm 0.01\AA$.

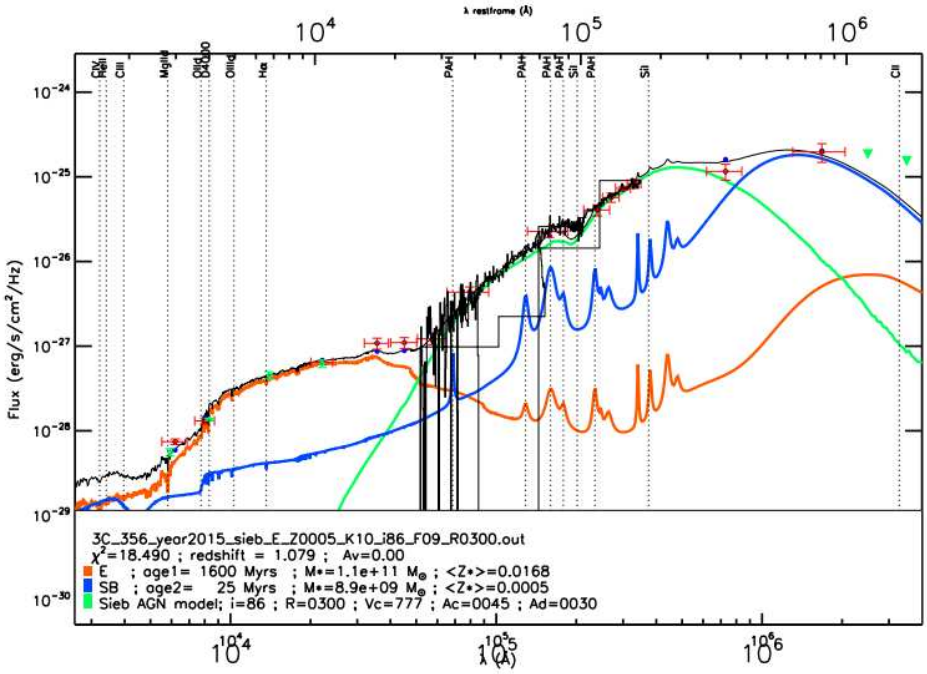

Figure 1: The UV-farIR best-fit of the radio galaxy 3C356 (z=1.079, i=86deg) with hybrid models of AGN and Pégase3, shows the IR torus emission (green) and synthetic stellar young (blue), old (orange) populations and total (light black line), (Drouart et al., 2016, Podigaschoski et al., 2016).The observations are from HST and SPITZER/IRAC filters (red squares) and the IRS spectrum (dark black line): in particular, this best-fit is considered as robust due to its consistency with this observed $SPITZER/IRS$ spectrum.

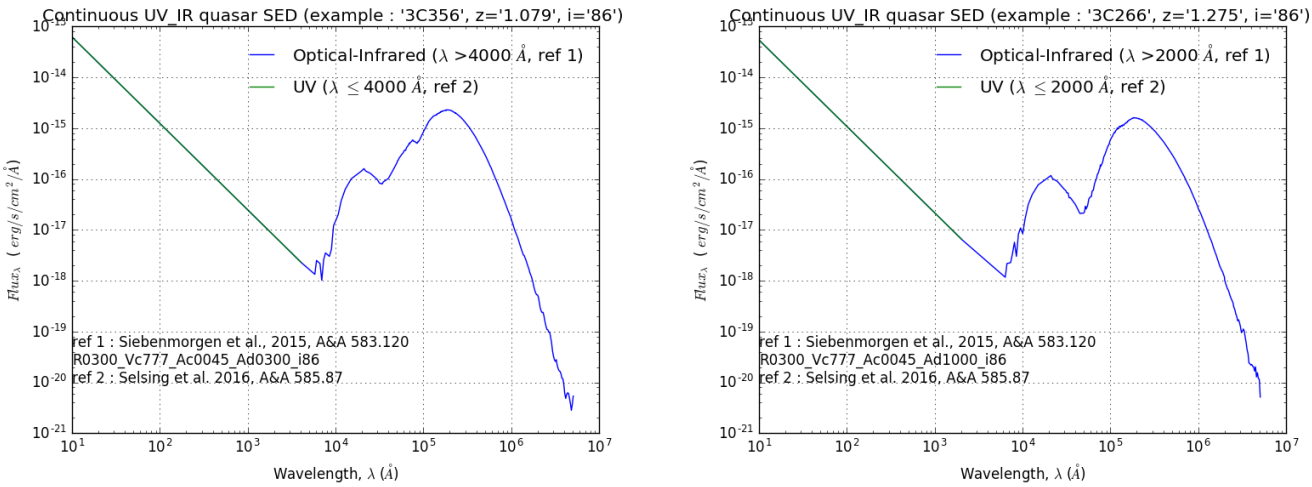

Figure 2: The UV - IR SED of quasars is presented by connecting the two UV (green line) to IR (blue line) components of the torus emission for, as examples, the two 3CR radiogalaxies 3C356 and 3C266. This last galaxy and other 3CR galaxies (see Fig.3 from Podigachoski et al, 2016) show the surprising continuity of the two components at the respective junction wavelength (4000Å for 3C356 and 2000Å for 3C266). The templates depend on z and on the AGN-axis inclination on the line of sight.

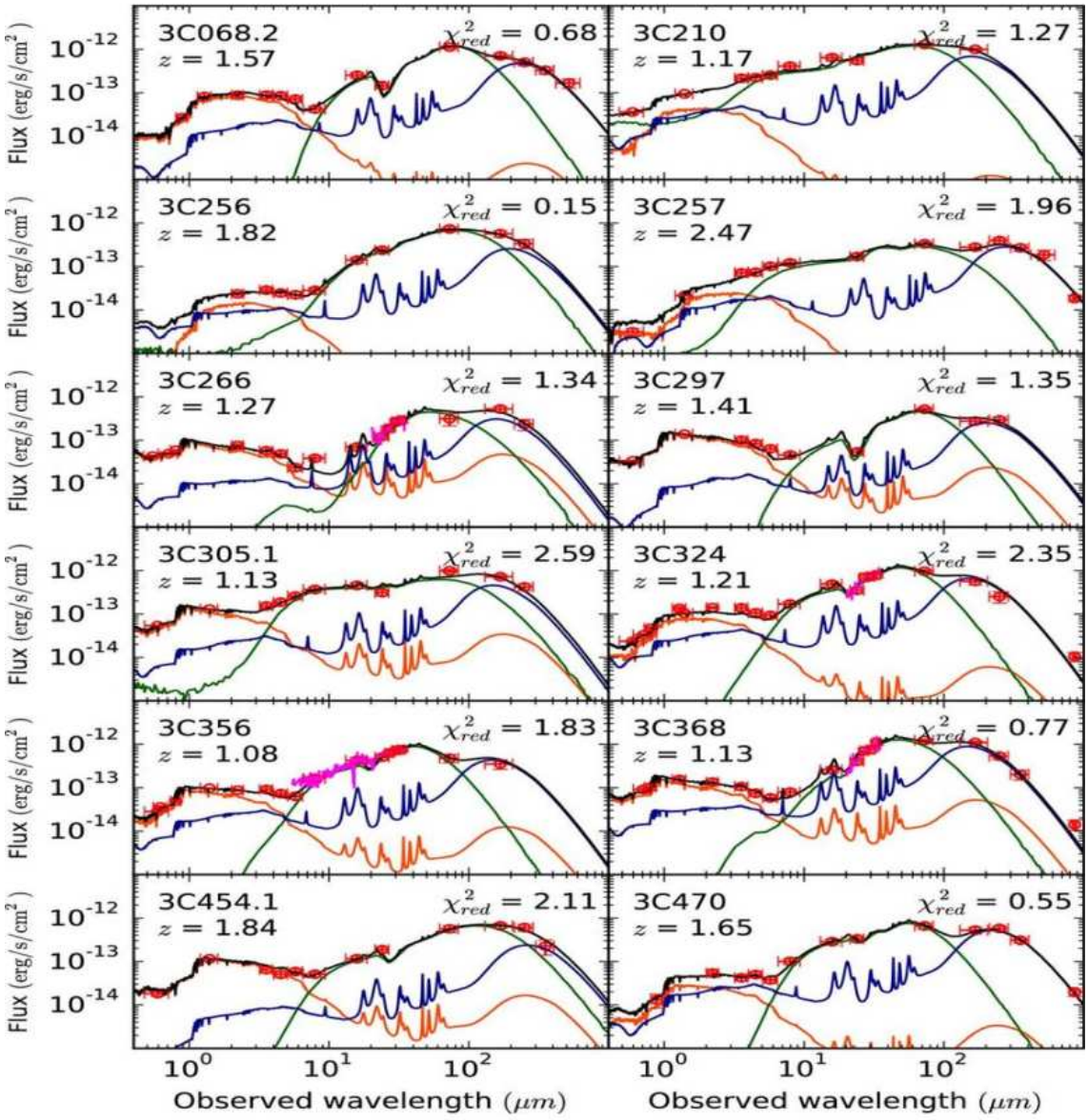

Figure 3: The three components (AGN, old galaxy and recent burst) of the 3CR radiogalaxies (Podigachoski et al, 2016). Identified with Pégase3 and Siebenmorgen et al. 2015, all show the same 3-component distribution for various redshifts

This UV-near-IR infrared slope, typical of quasars, is connected with the IR torus emission from the observed SED of the 3CR radiogalaxies (see section 1). While Fig.2 presents two examples (3C356 and 3C266) chosen for their $IRS-Spitzer$ spectrum fitting, the disentangling is applied to the 3CR sample (Fig.3). The most surprising result is the continuity of the two slopes of the AGN models at the junction domain: 2000Å for 3C356 and 4000Å for 3C266. These templates mainly depend on z and inclination, and also other physics parameters adopted by Siebenmorgen et al., 2015 through their library of 7000 SEDs for a broad range of luminosities, sizes and obscurations.The radiative transfer is tested on nearby galaxies in spherical symmetry for a stellar cluster permeated by an interstellar medium with standard (Milky Way) dust properties. Similarly the subtracted IR dust emission of galaxy components (host galaxy and burst) with Pgase.3 is coherent through MonteCarlo simulations with the absorbed energy by dust grains with local observed galaxies.

3. CONCLUSION AND FUTURE

For the 3CR galaxies, a continuous and significant link from the UV to IR domains of the torus emission is observed in the 3CR galaxy sample.The relation depends on the distance z and on inclination of the torus axis. These templates, assimilated to quasar templates, may be convolved through the pass-bands of the filters to better analyze the high spatial resolution of quasar data from the satellite Gaia, the relation between star formation and AGN activities hinted by the different thermal peaks in the far-IR. In the mid-IR, these templates will be helpful for data analyzes with better spatial and spectral resolutions of the *JWST/NIRcam, MIRI, NIRspec* instruments. We plan to build Pégase.3 template libraries and corresponding synthetic colors to help the community for the future data.

4. REFERENCES

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