Rapid host galaxy growth in powerful radio-loud AGNs: the Herschel view

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Goal: Investigate the star formation – active galactic nucleus (AGN) symbiosis in some of the most massive galaxies, the hosts of radio-loud AGNs.

Method: Carry out *Herschel* photometry: assess the far-infrared (FIR) spectral energy distribution (SED) properties of high redshift 3CR objects.

Introduction

A robust scaling relation between the mass of the supermassive black hole (SMBH) and the global properties of its host spheroid has been established in local galaxies. This strongly hints to an earlier link between black hole accretion and star formation, but the details of this scenario are yet to be fully understood. Both these processes underwent their peaks at around redshift of two, thus probing active massive galaxies in this particular redshift range is arguably the best strategy to constrain the coeval black hole and host galaxy growth. The advent of *Herschel* allows us to unambiguously quantify the thermal dust emission from active galaxies over cosmic time, and thus to address the respective contributions from AGN accretion and star formation.

Sample

The data were obtained as part of our *Herschel* Guaranteed Time project '*The Herschel Legacy of distant radio-loud AGNs*', (PI: Barthel). The sample includes the virtually complete Revised Third Cambridge Catalogue (3CR) of sources with $1 < z < 2.5$, and a representative selection of Fourth Cambridge Catalogue (4C) sources, to extend our redshift distribution to $z = 3$. The 3CR catalogue of sources is the brightest low-frequency-selected radio-loud AGN sample: these extremely luminous double lobed radio galaxies and quasars are governed by some of the most powerful accreting supermassive black holes known at any redshift. Prior to *Herschel*, these objects were visited by most major space and ground based facilities.

Data Analysis

The relevant data reduction and photometry tasks, both for *PACS* and *SPIRE*, were performed within the latest *HIPE* release. Combined with other available ancillary data (SDSS, UKIDSS, Spitzer, SCUBA, etc.), we fit the optical-to-FIR SEDs of our objects, using a linear combination of several components (see Figure 1).

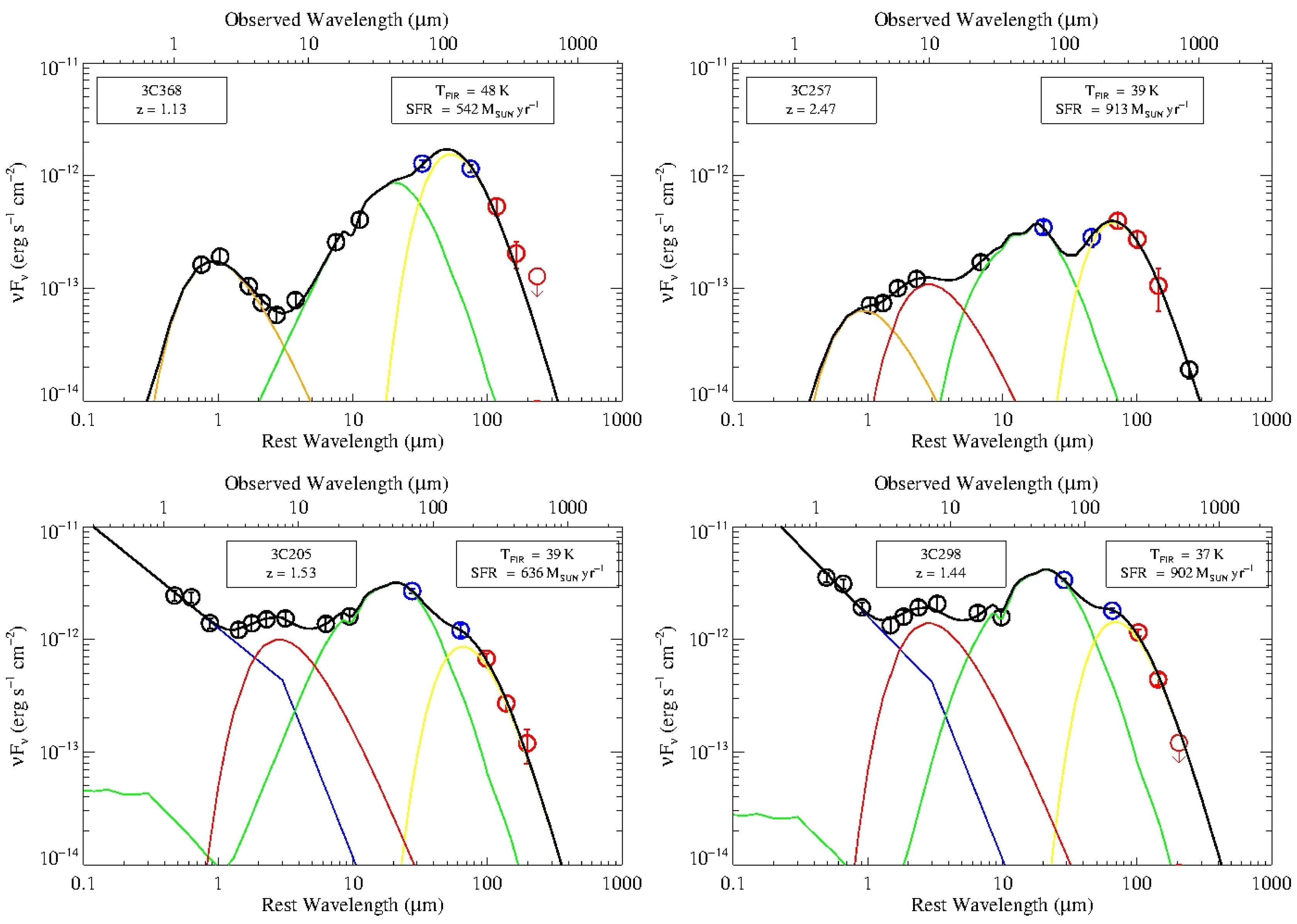

Fig.1 Best fit spectral energy distribution (black) for two radio galaxies (upper panels) and two quasars (lower panels). Green: AGN torus model from Hönig and Kishimoto (2010, A&A 523, 27). Orange: a blackbody component for the host galaxy. Blue: a broken power-law component (accretion disc). Red: a blackbody component with fixed temperature (hot inner torus dust). Yellow: a modified cool blackbody for the excess emission due to star formation in the FIR. *PACS* and *SPIRE* data points shown in blue and red respectively.

Results

Using this approach, we estimate AGN/star-formation luminosities and cold dust temperatures/masses, and provide robust upper limits in cases of *Herschel non-*detections. Many of the objects in our sample are prodigious star-formers (highly obscured in the UV/optical bands) with SFRs on the order of several hundreds solar masses per year, and cold dust temperatures in the range of those measured for distant submm galaxies (35-55 K).

Prospects

Being selected independently of orientation, the 3CR sample offers the unique possibility to create tests for the Unified Model of radio-loud AGNs. Furthermore, the well studied radio morphology of the objects allows for studies of trends related to the duration of the AGN phase. Finally, in combination with data of z<1 and z>3 radio-loud AGNs from other projects, we will look for possible evolutionary trends within this particular galaxy population.

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