Semester Report 2018/2019 Autumn

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Ph. D. Thesis Title: Star formation and active galactic nuclei

Introduction

Infrared wavelengths hold the key to understanding the evolution of galaxies. From the spectrum of the extragalactic background radiation (Hauser & Dwek 2001), we see that much of the light emitted by stars is absorbed by dust and re-emitted at mid- and far-infrared wavelengths. Only by understanding infrared extragalactic populations can we hope to get a reliable census of the star formation history of galaxies and estimate the fraction of dust-obscured active galactic nuclei (AGNs). Dust-obscured galaxies (DOGs) recently shed light on the co-evolution issue, because super massive black holes (SMBHs) in DOGs are expected to be rapidly growing during the co-evolution. DOGs are originally defined as galaxies that are bright in mid-infrared (MIR) while faint in optical (Dey et al. 2008; Fiore et al. 2008). In the context of the gas-rich major merger scenario, it is expected that the star forming (SF) phase evolves to the AGN-phase because the merging event leads to the active SF while the gas accretion onto the nucleus caused by such a merger requires some time (e.g., Davies et al. 2007; Hopkins 2012; Matsuoka et al. 2017). Since such active galaxies are expected to be heavily surrounded by dust, DOGs potentially correspond to galaxies in the SF-phase or AGN-phase (Dey et al. 2008; Hopkins et al. 2008).

In last two semesters, The AGNs parameters were studied in ELAIS N1 field by analysis the spectral energy distributions (SEDs) for different types of active galactic nuclei .

Description of research work

DOGs are classified into two sub-classes based on their spectral energy distribution (SED), which are “Bump DOGs” and “Power Law (PL) DOGs” (Dey et al. 2008). The bump DOGs show a rest-frame 1.6 μm stellar bump in their SEDs, while the PL DOGs show a power-law feature on their SEDs. Therefore, it is considered that the bump DOGs correspond to galaxies in the SF-mode (Desai et al. 2009; Bussmann et al. 2011) while the PL-DOGs correspond to galaxies in the AGN-phase (Fiore et al. 2008; Bussmann et al. 2009; Melbourne et al. 2012). The fraction of PL DOGs among all DOGs increases with increasing the MIR flux density (e.g., Dey et al. 2008; Toba et al. 2015), which is similar to the behavior of the luminosity dependence of the AGN fraction in ultra-luminous infrared (IR) galaxies.

Our DOGs’ sample (18 DOGs) were discovered by (Toba 2015) through combining wide and deep optical images obtained with the Hyper Suprime-Cam on the Subaru Telescope and all-sky mid-IR (MIR) images taken with Wide Field Infrared Survey Explorer This sample with $i - Ks > 1.2$ and $i - [22] > 7.0$, where i, Ks, and [22] represent AB magnitude in the i-band, Ks-band, and 22 μm, respectively, in the GAMA 14 hr. field (~ 9 deg2). The new Herschel point source catalogue data is combined with (i & z) bands, 2MASS, and WISE photometry data, creating spectral energy distributions (SEDs) that cover the rest-frame wavelength range from far-UV to far-IR (from 0.15 to 160 micrometer). The SEDs were modelled using the **CIGALE** software (S. Noll et al. 2009), deriving galaxy properties with a high reliability by fitting the attenuated stellar emission and the related dust emission at the same time. I select here 3 of our sample with clear description of the selected sources in table 1, followed by their SEDs.

Table 1: Most important properties of the selected DOGs

ID	Redshift	SFR ($M_{\odot}$/yr)	AGN Luminosity $\times10^{39}$ (W)	Stellar Luminosity $\times10^{39}$ (W)	Dust Luminosity $\times10^{39}$ (W)	Stellar mass $\times10^{11}$ ($M_{\odot}$)
DOG1	2	610	2.1	0.38	1.6	2.3
DOG2	2	227	1.8	0.19	0.85	1.3
DOG3	2	556	1.4	0.16	0.65	1.6

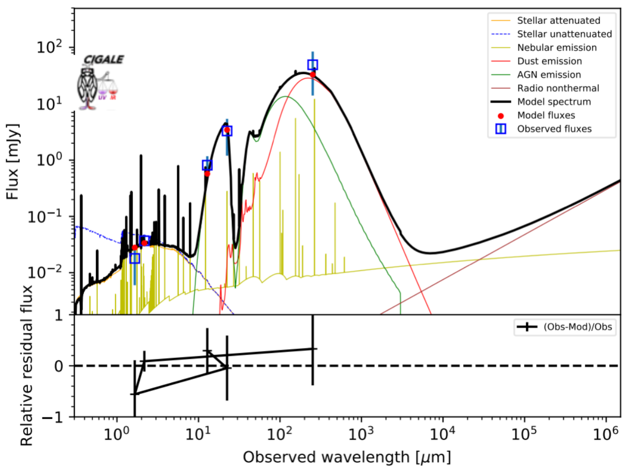

Figure 1: The SED of DOG1

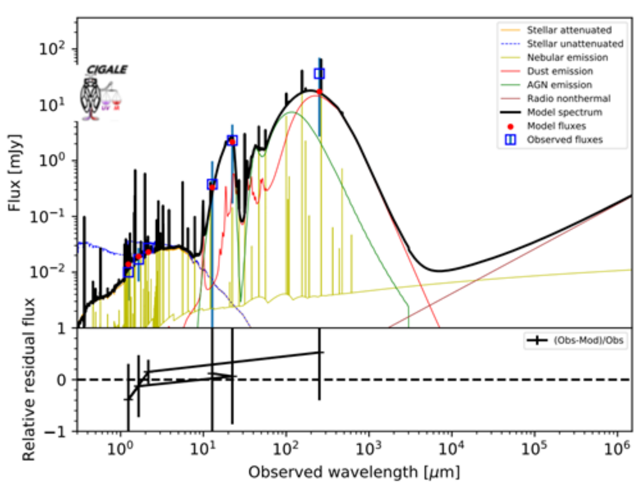

Figure 2: The SED of DOG2

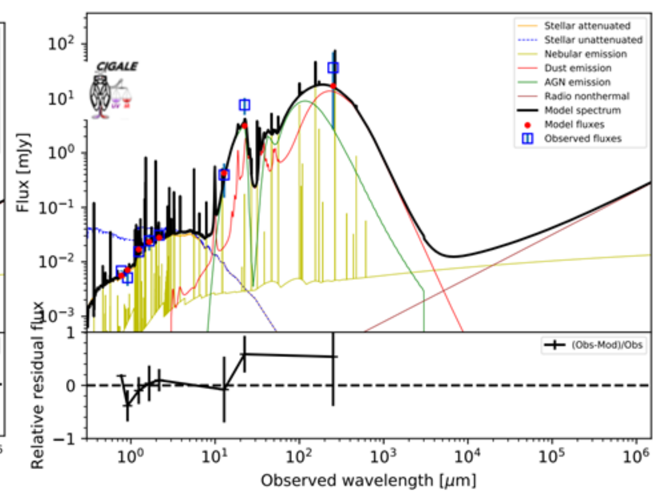

Figure 3: The SED of DOG3

Publications

- **Suleiman N.**, Al-wardat M., Talafha M., AL-Ameryeen H., Toth V. (2018). Astronomy education in Jordan. Proceedings of the International Astronomical Union, accepted in October 2018.
- **Suleiman N.**, Toth L. V., Kovacs T., Pinter S., Frey S. (2018). AGN parameters in the ELAIS field using CIGALE. Proceedings of the International Astronomical Union, accepted in September 2018.

- Dénes, H., Jones P.A., Tóth L.V., Zahorecz S., Koo B-C., Pinter S., Racz I.I., Balázs L.G., Cunningham M.R., Doi Y., Horvath I., Kovács T., Onishi T., Bagoly Z., & **Suleiman, N.** (2019). Exploring the pattern of the Galactic HI foreground of GRBs with the ATCA. Submitted to Monthly Notices of the Royal Astronomical Society.

Studies in current semester

- FIZ/2/025 – The physics of interstellar matter I – Dr. L. V. Toth
- FIZ/2/118 – High energy Astrophysics – Dr. Norbert Werner
- FIZ/KUT-S3 – Guided research work – Dr. L. V. Toth
- Attended the 10th IRAM millimeter interferometry school October 1st - 05th 2018 at the IRAM headquarters (Grenoble, France).

Conferences in current semester

- Attended General Assembly of International Astronomers Union (IAU) in focus meeting 03; Radio Galaxies: Resolving the AGN phenomenon with poster contribution & focus meeting 15; Astronomy for Development with poster contribution, Aug. 20th to 31st 2018 at Vienna, Austria.
- Submitted abstract as oral contribution to Zooming in on star formation, June 10th -14th 2019, Nafplio, Greece.
- Submitted abstract as oral contribution to Exploring the IR Universe (the promise of SPICA) May 19th -23rd 2019, Island of Crete, Greece.

Activities

- *Awards:* ELTE Talent Support grant – Budapest, Hungary, Autumn Semester 2018/2019.
- *Workshop:* Young Astronomers on Galactic Nuclei, October 29th-31st at ELTE University.

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