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Properties of AGN in NIR within the context of the Eigenvector 1

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Abstract. We present a spectral atlas of 70 type-I AGN with the wavelength ranging 0.4–2.5 μm. For 37 sources, this is the first report of NIR spectroscopy in literature. The sample was constructed to study narrow line Seyfert 1 and quasars, with a large range of line widths (800 km s^{-1} < FWHM < 4000 km s^{-1}) and Fe II intensities ($0.2 < R_{4570} < 2.8$). This work presents partial results of an ongoing project that has the objective of modeling the continuum emission and emission lines in order to derive the physics driven the Eigenvector 1 through a panchromatic spectral analysis, with emphasis on strong to super-strong Fe II emitters. Our results show that hot dust near the sublimation temperature is necessary to explain the 1μm break of the power law component of the continuum. We estimated the hot dust mass and found a weak or absent correlation with the Fe II intensity. Moreover, we found that low ionisation ions are formed in an outer region of the BLR.

Keywords. active galaxy nuclei, Seyfert, infrared, emission lines, spectroscopic

1. Introduction

An Active Galactic nuclei (AGN) is an energetic phenomenon which produces electromagnetic spectrum features in a broad range of wavelength. Narrow-line Seyfert 1 galaxies (NLS1) are a particular subclass of AGNs due to some specific characteristics. In these sources, the Balmer lines are narrower than a normal Seyfert 1 (FWHM < 2100 km s^{-1}), shows a stronger Fe II emission, and weaker [OIII] lines ([OIII/Hβ] < 3) (Shen & Ho (2014)). These objects are important in the physics context of the Eigenvector 1 (EV1) since they represent extreme objects in the quasar main sequence. The physical drivers of the EV1 are not completely understood yet, specially in the extreme cases such NLS1, and in order to improve our knowledge on these sources it is necessary to study how to distinguish these extreme objects.

In this work, we selected a sample of Type-I sources with extreme properties in the EV1 context. The 70 AGN in the samples covers the near infrared region from 0.4–2.5 μm. For 37 out of 70 sources, this is the first report of NIR spectroscopy in literature. We aim to model the continuum and measure the emission line properties, to derive its physical properties within the context of the Eigenvector 1.

2. Methodology and Database

We present for the first time near-infrared observations of 37 Type-I AGN optically identified as strong Fe II emitters. Additionally we complete the sample with previously published data of other 33 AGN from Riffel *et al.* (2006) and Marinello *et al.* (2016), achieving a broad range of Fe II emission ($0.2 < R_{4570} < 2.8$) and a redshift coverage of $0.002 < z < 0.2$.

In order to keep consistency in the methodology used to measure R_{4570}† we re-estimate this quantity using the optical spectral available for our sample. For the 46 out of 70 AGN we had the optical spectrum available. We modeled the continuum using a power law and the bump centered at $4570AA$ using the template from Boroson & Green (1992). For 33 out of 46 objects we measured $R_{4570} > 1$, which classifies them as strong Fe II emitters.

In order to analyse the continuum shape in the NIR we modeled this emission using to main components: (i) a power law, which extends from the UV to the NIR; and (ii) a black body, which is responsible for pump up the continuum at wavelengths redward $1.2\,\mu$m. The power law index is an important parameter in the SED modeling, and gives information of how much flat is the optical spectrum. On the other hand, the black body component gives information on how warm is the dust present in the outer region of the BLR (Rodriguez-Ardila *et al.* (2006)), and allow an estimative of the dust mass in this region, which it is derived from the $2.2\,\mu$m flux (Barvainis (1987)).

To probe the Fe II emitting region we use different low ionization emission lines, which are believed to be produced in the same region as Fe II, such as O Iλ8446 and Ca IIλ8663, and compare them with Paschen and H IIλ10830 lines. To model the profile of these lines we used the python library LMFIT. We fit the lines deblending the broad and narrow component using Lorentzian and Gaussian profiles, respectively, in order to obtain their FWHM, flux, and centroid.

3. Results and Conclusions

Our results shows the presence of dust emission heated by a AGN at T > 1000 K, likely representing the emission from the torus, a common characteristic in the NIR continuum of Type I AGN (Rodriguez-Ardila *et al.* (2006)). This dust could, hypothetically, carry iron grains towards the BLR via eccentric movement of dust cloud within the torus. In order to test this hypothesis we compare the dust mass with R_{4570} to verify a possible correlation. Our results show, however, a very week correlation between the dust mass and the Fe II intensity. We obtain a very flat correlation with a Spearman Rank Coefficient $S_r = 0.15$, with a $p - value = 0.35$. This suggests the absence of dust in the Fe II emitting region, which means that the hot dust observed in the continuum is probably the warm internal face of the torus.

We found similar values of FWHM for Ca II, O I and Fe II. Assuming a virialized movement for the BLR clouds, this result suggests a similar region of formation for these ions, in an outer part of the BLR. On the other hand, the FHWM of He II and Hydrogen are systematically larger than Fe II, suggesting a inner formation regions for these lines.

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† The R_{4570} was defined as the flux ratio between Fe II complex centered at 4570 Å and the broad component of Hβ.

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