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# AN ANALYSIS OF THE INFRARED AND OPTICAL CONTINUA OF SEYFERT 2 GALAXIES

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ABSTRACT. The infrared-optical continua of nine Seyfert 2 nuclei are analysed. The observed spectra are fitted by three components: a power law, a low temperature ($T \sim 200K$) and an intermediate temperature ($T \sim 3800K$) black-body.

Key words: Seyfert galaxies; infrared continuum; optical continuum

## I. INTRODUCTION

The optical continuum of the active galactic nuclei (AGN) have been represented by a power law. Photoionization models, constructed to explain the line-emission of these objects, considered the ultraviolet ionizing radiation as an extrapolation of the optical non-thermal continuum. However, some models indicated that this extrapoleted power law does not supply enough ionizing photons (Shields, Oke, 1975; Stasisnka, 1984). On the other hand, detailed analyses of several AGN continua, from the infrared to the ultraviolet, have shown that a model including a thermal and a non-thermal continuum gives a good fit to observations (Neugebauer et al., 1976; Malkan, Sargent, 1982).

In this paper, the infrared-optical continuum of nine Seyfert 2 nuclei are studied. For each object, to construct the composite infrared-optical spectrum published spectrophotometric data are used.

## II. RESULTS

The optical data come from De Bruyn, Sargent (1968), where the absolute spectrophotometry of 68 Seyfert galaxies are presented. From this sample, we have chosen the Seyfert 2 with available infrared data, particularly, those with observations at $10\mu$. The flux at $10\mu$ is important te determine the non-thermal component. The infrared data are taken from

Cruz-Gonzalez (1984), Neugebauer et al. (1976) and Rieke et al. (1975). The selected objects are listed in Table 1.

Table 1

| | | Power law | | BB. Optical | | BB. Infrared | |
|---|---|---|---|---|---|---|---|
| OBJECT | $z_{em}$ | $\alpha$ | log $F_{4800Å}$ | T(K) | log $F_{4800Å}$ | T(K) | log $F_{10\mu}$ |
| Mrk 1 | 0.016 | 0.98 | -26.13 | 3900 | -26.04 | 160 | -24.20 |
| Mrk 3 | 0.014 | 0.78 | -25.93 | 3300 | -25.46 | 220 | -23.42 |
| Mrk 34 | 0.051 | 1.53 | -26.54 | 5000 | -25.87 | 2500 | -25.98 |
| Mrk 78 | 0.038 | 1.55 | -26.49 | 3900 | -25.73 | 200 | -25.68 |
| Mrk 176 | 0.027 | 1.86 | -25.59 | 4400 | -25.72 | 1400 | -24.42 |
| Mrk 198 | 0.024 | 1.24 | -26.28 | 4500 | -25.68 | 200 | -24.39 |
| Mrk 273 | 0.038 | 1.50 | -26.08 | 3500 | -25.86 | 200 | -24.54 |
| Mrk 348 | 0.014 | 1.92 | -26.11 | 4100 | -25.79 | 200 | -24.48 |
| NGC 1068 | 0.003 | 1.61 | -24.69 | 4100 | -24.48 | 180 | -22.20 |
| | | | | | | 520 | -22.09 |

We assume the infrared-optical continuum as composed by: a power law, a low temperature black-body (representative of infrared emission) and an intermediate temperature black-body (representing the contribution of stellar continuum). The fitting was done by non-linear least-squares of log F. For each object, the results of the best fit are given in Table 1. For the power law the spectral index, $\alpha$, and the contribution to the flux at 4800 Å (in units of $10^{-25}$ ergs $cm^{-2}$ $s^{-1}$ $Hz^{-1}$) are listed. For the black-body components, the temperature and the contribution to the flux at the indicated wavelength are presented.

The observational data as well as the final fit and its decomposition are illustrated in Figures 1 and 2, respectively, for Mrk 1 and NGC 1068. It can be seen in Figure 2 (and Table 1) that two thermal components, added to the power law, are needed to fit the observed infrared emission, in this case.

## III. SUMMARY AND DISCUSSION

It can be noted (Table 1) that for seven Seyfert 2 nuclei the infrared thermal component has a temperature in the range $150 < T < 220$ K, which can correspond to the emission by heated dust as suggested by Neugebauer (1978). For Mrk 34 and Mrk 176, the thermal component contributing to the infrared emission presents a higher temperature $1400 < T < 2500$ K. This component may represent thermal emission from superheated dust but dust grains do not survive at temperatures above $\sim 1000$ K (Rieke and Lebafsky, 979). Alternatively, it can be explained by the stellar contribution of broader spectral class interval, that cannot be fitted by a single black

Figure 1

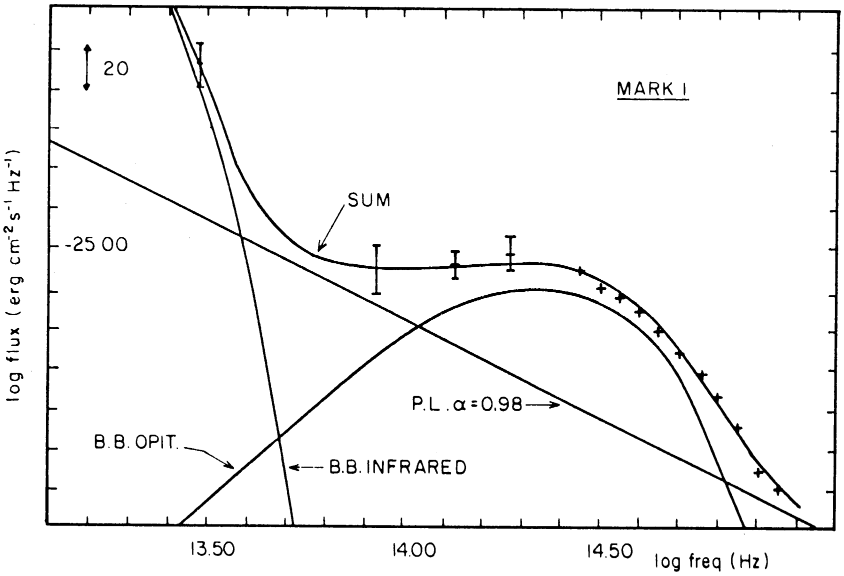
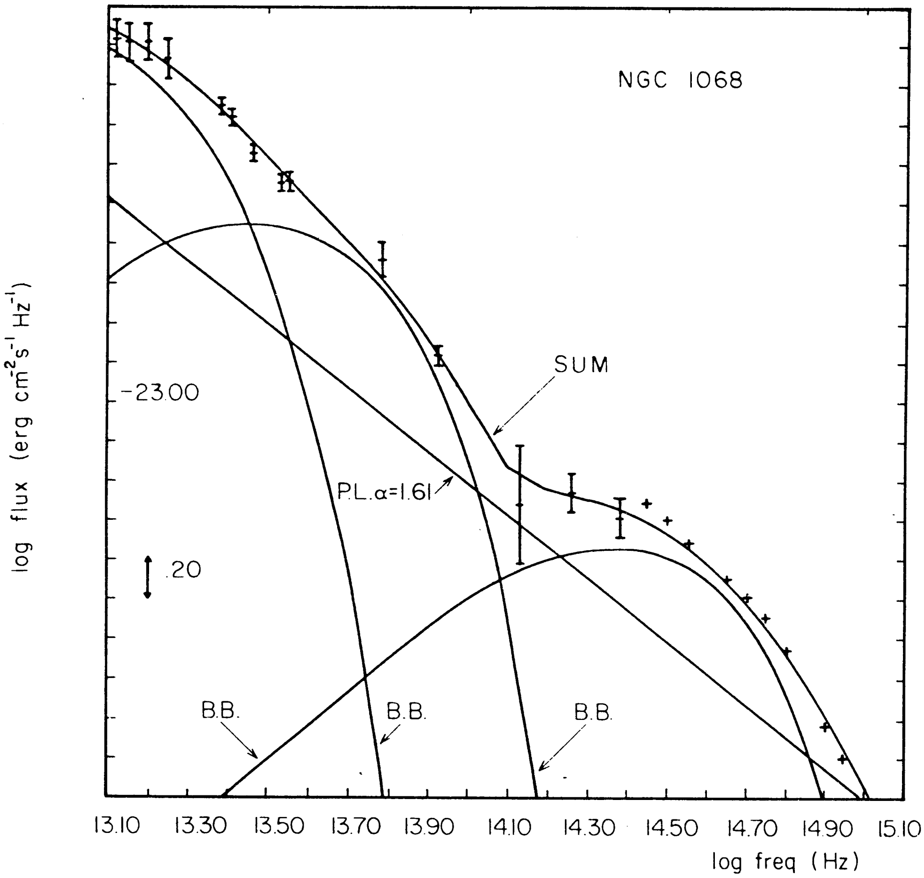



Figure 2



body curve. This circumstance may also account for the double law temperature emission of NGC 1068.

Regarding the optical thermal component, its temperature is in the range 3300 < T < 5000 K and corresponds to the stellar emission of the host galaxy. It must be noted that the optical continuum of M31 (Sandage et al., 1969) can be fitted by a single black-body with T $\simeq$ 3900 K.

Finally, the spectral index of the non-thermal component varies from 0.78 to 1.92. The relative importance of this component depends on the object. The extrapolation of the power law to the ultraviolet frequencies gives the number of ionizing photons, allowing the calculation of the expected H$\beta$ luminosity, $L_{H\beta}$, and the HeII$\lambda$4686/H$\beta$ line intensity ratio, $\eta$. A comparison between the observed $L_{H\beta}$ and $\eta$ values (Koski, 1978) and the calculated ones shows that, except for Mrk 3, all the other studied Seyfert 2 nuclei need a supplementary ultraviolet component to explain the observed lines. This component may come from an accretion disk.

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