

MULTIVARIATE STATISTICAL ANALYSIS OF THE SAMPLE OF A G N

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ABSTRACT. Radio, FIR, spectral and X-ray data by 11 parameters for the AGNs samples of Sy1, Sy1.5, Sy2 types and LINERs are compiled. All samples are processed by the multivariate statistical methods including factor and discriminant analyses. The following results are obtained:

- LINERs by principal factors, determining NLR and the central engine are clearly separated from the Seyfert galaxies.
- All types of the Seyfert galaxies in all have the same NLR.
- Intermediate Seyfert type is real. These AGNs are much more similar to Sy1 type objects than to Sy2.

1. POSITING OF THE PROBLEM.

To classify the AGNs usually the information about the profiles and the observed emission lines intensities is used (Khachikian, Weedman, 1971; Osterbrock, 1977, 1981; Heckman, 1980). Meanwhile, for the large number of AGNs there are rich observational data about radio, IR, optical and X-ray properties also.

We consider the problem, if there are other independent parameters or groups of those which describe and classify the AGNs.

To answer this we choose the samples of AGNs (classified in the classical manner) Sy1 (29 objects), Sy1.5 (25 objects), Sy2 (22 objects) and LINERs (28 objects) for which the data by 11 parameters are compiled. These parameters are: $\lg[\text{OIII}]/\text{H}\beta$, $\lg[\text{OII}]/[\text{OIII}]$, $\lg[\text{NII}]/[\text{OIII}]$, $\lg L_{21\text{cm}}/L_{[\text{OIII}]}$, $\alpha_{6\text{cm}}^{21\text{cm}}$ and $\lg L_{\text{FIR}}/L_{[\text{OIII}]}$, $\alpha_{25\mu}^{60\mu}$, $\alpha_{60\mu}^{100\mu}$, $\lg L_{(0.5-4.5\text{keV})}/L_{[\text{OIII}]}$, b/a and $\lg \text{H}\alpha/\text{H}\beta$. Let us note that for Sy1.5 the last parameter and also the ratio $\lg[\text{OIII}]/\text{H}\beta$ separately for NLR and BLR are taken. The missing data of the same parameters of a certain number of

objects are replaced by the mean value of the parameters of the given type of AGNs.

To determine the number of independent underlying parameters, the complete sample of AGNs by the method of multivariate statistical factor analysis is processed (Harman 1967). On the basis of revealed independent factors another classification of AGNs is done by the method of multivariate statistical discriminant analysis (Afifi, Azen, 1979).

2. RESULTS AND DISCUSSION.

By realization of factor analysis on the complete sample of AGNs, three principal factors are obtained. With threshold value $r > 0.6$ in the first factor (explaining about a half of common dispersion of data) the parameters describing the degree of excitation in NLR (of about size 1 kpc), radio and FIR properties of AGNs are distinguished. It is known that the main source of the radio emission of active galaxies is in their nuclear region and has the size of not more than a few hundred parsecs (Wilson and Heckman, 1985). FIR radiation usually is concentrated also in the central region of galaxies with $r \geq 100$ pc (Edelson et al, 1987). So, the first factor, which groups the mentioned parameters, describes general properties of NLR in AGNs. The second factor explaining about 15% of the common dispersion of data, depends significantly upon one parameter only the X-ray luminosity of AGNs. So the X-ray radiation originating in the region close to the central engine of AGNs (Kriss et al, 1980) is an independent parameter and does not directly influence on the properties of NLR in AGNs. The axial ratio of parent galaxies of AGNs as an independent parameter conditioning the third factor is distinguished. So the slope of parent galaxies of AGNs does not influence on the observational data of their nuclei.

Considering Sy1.5, Sy2 and LINERs only and taking into account the reddening parameter $\lg H_{\alpha}/H_{\beta}$ in NLR we observe a considerable correlation between $\lg H_{\alpha}/H_{\beta}$ and X-ray luminosity. Together, they characterize the second factor. As the result of the factor analysis application on the sample of Sy1 and Sy1.5 only, considering the reddening parameter $\lg H_{\alpha}/H_{\beta}$ in BLR, the X-ray luminosity groups with it too. The fact of correlation of the AGNs X-ray luminosity with NLR and BLR reddening factors may be considered as an argument in favour of the hypothesis that there is only one kind of AGNs and the observed variety arises partly from the effects of extinction of the radiation of the central source (Lawrence, 1987).

For the complete sample of AGNs, in comparison with the coefficients of the first and the second factors (Figure 1) LINERs are separated from the Seyfert nuclei.

The coefficients of the first factor for all Seyfert galaxies is not distinguished by the K-C test (Figure 1). This means that Seyferts of the 1, 1.5 and 2 types have similar NLR properties.

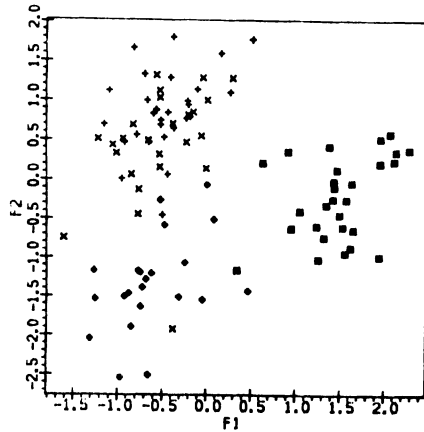


Figure 1. Distribution of the coefficients of the first and the second factors for Sy1(+), Sy1.5(x), Sy2(*) and LINERs (■).

At the same time the difference in X-ray luminosity (the second factor) between various types of Seyfert is significant. This parameter being independent clearly classifies Seyferts into types.

The second classification of AGNs according to the obtained factors shows that all the considered LINERs and Sy2s remain the same. The Sy1 galaxies Mkn 124, 304, 374, NGC 3516, 3783, IIZw136 and IZw1 have the same properties as Sy1.5s. Intermediate type Seyfert galaxies Mkn 279 and 590 are closer to Sy1s.

The case of NGC 1365 is interesting. In this galaxy, according to the spectrophotometrical data (Edmunds et al, 1982), the central compact Sy1.5 type nucleus is embedded in the region with the size 400 pc, showing some properties of Sy2 type AGNs. Our classification of NGC 1365 confirms this picture. According to the NLR parameters it is clearly classified as Sy2. Adding the parameters of BLR ($\lg H_{\alpha}/H_{\beta}$) NGC 1365 becomes Sy1.5.

*) When our work was completed we obtained the article of Dahari and de Robertis (Space Telescope Sci.Inst.prep. No. 238, 1988). They classify Mkn 304 as Sy1.8 and Mkn 374, NGC 3516, IZw1 as Sy1.5.

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