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Tri-dimensional Spectroscopy of the Seyfert Galaxy NGC 1275: Kinematics and Excitation of the Cooling-Flow Gas

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1. Introduction

NGC 1275, the Perseus cluster cD galaxy, is a well-known Seyfert 1 galaxy and also one of the strongest extragalactic radio sources (3C 84). Although many studies have been done on the extended optical emission-line region of NGC 1275, which is thought to be associated with the X-ray cooling-flow phenomenon (e.g., Heckman et al. 1989, Ferruit and Pécontal 1994), the excitation mechanism of the emission-line gas and two-dimensional gas kinematics are still unclear. We made tri-dimensional spectroscopy of NGC 1275 in order to reveal two-dimensional kinematics and the relation between the gas motion and the excitation of the emission lines.

2. Observations

The position angle of the slit was 90° and a 5′ (EW) by 18″ (NS) area of the central region of the object was scanned. The spectral range 6100–6800 Å was covered with a spectral resolution of 2000.

3. Results and Discussion

Emission-line images of NGC 1275 in Hα, [N II], [S II], and [O I] were obtained. The distribution of the [O I]-emitting region is similar to that of other emission lines in large scale. The velocity field is very complicated and global rotational motion does not exist. Many kinematically distinct filaments of clouds are superposed to the line of sight (Fig. 1). Two gas components, a high-velocity filament at about 8″ NE from the nucleus (NE-HVF), and a low-velocity, large velocity-dispersion gas cloud elongated toward the southwest direction from the nucleus (SW-LVF), were newly found. NE-HVF has a radial velocity of 5500 km s^{-1}, which is 300 km s^{-1} higher than the systemic velocity of the galaxy, and it is elongated along NW–SE direction for 5 kpc. Note that this filament is not a part of the so-called 'high-velocity system' whose radial velocity is about 8300 km s^{-1}. NE-HVF is possibly an infalling gas filament or a merging dwarf galaxy. The position angle of SW-LVF is similar to that of the VLBI jet and it suggests that

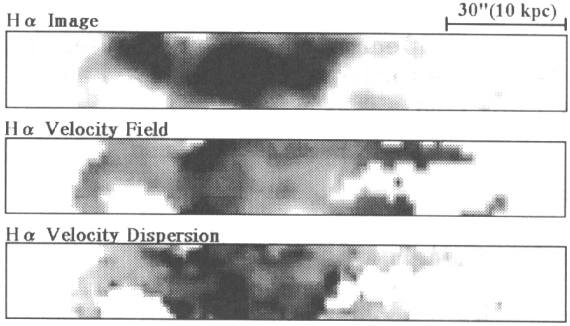

Figure 1. *Top:* Hα image of NGC 1275. *Middle:* Hα velocity field from 5000 km s^{-1} (lightest gray) to 5500 km s^{-1} (black). *Bottom:* Hα velocity dispersion from 0 km s^{-1} (white) to 450 km s^{-1} (black).

this component may be a nuclear outflow gas associated with the radio jet. The gas kinematics are well correlated with the emission-line intensity ratios. We find that a positive correlation between [N II]/Hα flux ratio and the Hα velocity dispersion. This suggests that the shock induced by turbulent gas motion and/or gas cloud–cloud collisions may play a important role in excitation of the optical filament of the cooling flow of NGC 1275. The distribution of the electron density n_e derived from [S II] line intensity ratio is patchy, and it seems that many high-density ($n_e > 300\,\mathrm{cm}^{-3}$) filaments or clouds are distributed in low-density ($n_e < 100\,\mathrm{cm}^{-3}$) background. The density of SW-LVF is relatively high, and this suggests gas compression by the outflow. Comparison between a ^{12}CO map obtained by Inoue et al. (1996) and our maps suggests that molecule formation in the cooling flow of NGC 1275 may be closely related with the optical emission-line region.

References

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