Simultaneous Observations of GRS 1758–258 in 1997 by VLA, IRAM, SEST, RXTE and OSSE: Spectroscopy and Timing

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abstract We report the results of our multi-wavelength observations of GRS 1758–258 made in August 1997. The energy bands include radio, millimeter, X-ray, and gamma-ray. The observations enable us to obtain a complete spectrum of the source over an energy range of 2 – 500 keV. The spectrum shows that GRS 1758–258 was in its hard state. It is well fitted by the Sunyaev-Titarchuk (ST) Compton scattering model with a plasma temperature of 45 keV and a Thomson depth of 3.3. Taking relativistic effects into account, we get a little higher plasma temperature (52 keV) by using the improved version of the ST model (HT model) plus a soft black-body component. The spectrum is also fit by a power law with an exponential cutoff (PLE) plus a soft black-body component. The temperature of the soft components in both models is about 1.2 keV, and the energy flux is less than 1.5% of the total X- and gamma-ray flux. The deduced hydrogen column density is in the range of $(0.93 \pm 2.0) \times 10^{22}$ cm$^{-2}$. No significant iron lines are detected.

The radio emission has a flat energy spectrum. The daily radio, X-ray and gamma-ray light curves show that GRS 1758–258 was stable during the observation period, but was highly variable on smaller time scales in X- and gamma-rays. The power density spectra are typical for the low-state, but we find the photon flux for the 5 to 10 keV band to be more variable than that in the other two energy bands (2 – 5 keV and 10 – 40 keV). Harmonically spaced quasi-periodic oscillations (QPOs) are observed in the power spectra. The phase lags between the hard photons and the soft photons have a flat distribution over a wide range of frequencies. A high coherence of about 1.0 (0.01 – 1 Hz) between the hard photons and the soft photons is also obtained in our observations. We compare these results with two variation models. Our millimeter observations did not reveal any conclusive signatures of an interaction between the jet from GRS 1758–258 and the molecular cloud that lies in the direction of GRS 1758–258.