

MOLECULAR GAS DYNAMICS IN SPIRAL ARMS OF M51

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We present the kinematics and dynamics of molecular gas in the almost entire disk ($>5 \times 5'$) of the grand-design spiral galaxy M51, derived from CO(J=1-0) observations with the Nobeyama 45-m telescope. The spatial resolution of $17''$, which corresponds to 790pc at the distance of M51 (9.6 Mpc), is enough to distinguish between a spiral arm and an interarm; therefore a clear spiral structure (cf Nakai et al, this conference) and large streaming motions of the molecular gas were revealed.

Figure 1 is the velocity field of the molecular gas in M51. It shows that the position angle of the major axis is about -10° . The velocity field is disturbed along the spiral arms: the motion of molecular gas deviates from circular motions. The deviation can be seen more clearly in position-velocity diagrams along the major and minor axes, where the tangential and radial velocity components are separated. The tangential velocity increases by about 15km/s and the radial velocity directed to the galactic center increases by about 20km/s, which correspond to 44 and 60km/s respectively in the galactic plane, inclined by 20° on the sky. These results indicate streaming motions of molecular gas: when the gas passes the shock regions along the spiral arms, the direction of the velocity vector is changed to the direction nearly parallel to the arms. As a result, the time-scale for molecular gas to stay in the spiral arms becomes larger than that for the circular orbits, and the density in spiral arms is enhanced.

The motions as mentioned above are expected from the density wave theory, and are reproduced in many simulations (e.g. Roberts 1969, Hausman and Roberts 1984). However the observed velocity shifts, especially the radial velocity shifts, are much larger than expected from the theory (≈ 20 km/s).

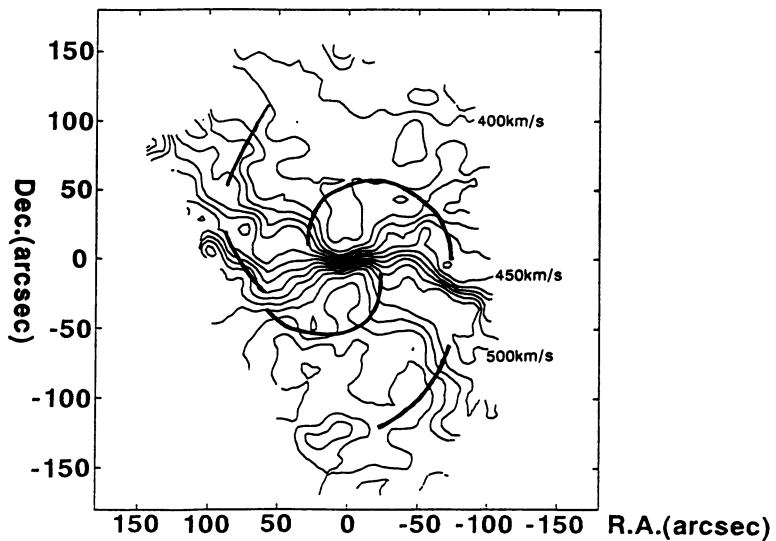


Figure 1: The velocity field of M51. Dust lanes are traced by thick lines

References

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