World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:14, No:04, 2020

Thick Disc Molecular Gas Fraction in NGC 6946

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Abstract : Several recent studies reinforce the existence of a thick molecular disc in galaxies along with the dynamically cold thin disc. Assuming a two-component molecular disc, we model the disc of NGC 6946 as a four-component system consists of stars, HI, thin disc molecular gas, and thick disc molecular gas in vertical hydrostatic equilibrium. Following, we set up the joint Poisson-Boltzmann equation of hydrostatic equilibrium and solve it numerically to obtain a three-dimensional density distribution of different baryonic components. Using the density solutions and the observed rotation curve, we further build a three-dimensional dynamical model of the molecular disc and consecutively produce simulated CO spectral cube and spectral width profile. We find that the simulated spectral width profiles distinguishably differs for different assumed thick disc molecular gas fraction. Several CO spectral width profiles are then produced for different assumed thick disc molecular gas fractions and compared with the observed one to obtain the best fit thick disc molecular gas fraction profile. We find that the thick disc molecular gas fraction in NGC 6946 largely remains constant across its molecular disc with a mean value of 0.70 +/- 0.09. We also estimate the amount of extra-planar molecular gas in NGC 6946. We find 60% of the total molecular gas is extra-planar at the central region, whereas this fraction reduces to ~ 35% at the edge of the molecular disc. With our method, for the first time, we estimate the thick disc molecular gas fraction as a function of radius in an external galaxy with sub-kpc resolution.

Keywords : galaxies: kinematics and dynamic, galaxies: spiral, galaxies: structure , ISM: molecules, molecular data
Conference Title : ICPCA 2020 : International Conference on Physics, Cosmology and Astronomy
Conference Location : Rome, Italy
Conference Dates : April 08-09, 2020