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Finding co-rotation resonance in spiral galaxies using localized observable features

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The co-rotation resonance of a spiral galaxy represents a stable region within the galactic structure where the velocity of the disk material and the spiral arm global pattern speeds concur with each other. The cardinal objectives of studying these regions include but are not limited to; checking the validity of theoretical predictions, getting a better understanding about the disk material distribution process and to study the evolution process of galaxies. Often these regions are attributed to galactic scale habitable zones; hence the study is undoubtedly a worthy pursuit. The co-rotation resonance region creates a radius of localized observable features that can be used to locate and study them. The current study focusses on using multiple methods such as spiral arm overlays by measuring pitch angles, arm-inter-arm contrast plots, 2D-fast Fourier transformation plots and 3-D surface intensity plots. Ten nearby galaxies were observed in 3.6 μm, 8 μm and B-band based on the availability and the clarity of image data. It is important to emphasize that the different wavelengths were selected based on their unique characteristic abilities to trace different structural components of the galaxy. B-band usually depicts the newly formed young stars while the 3.6 μm images are sensitive to the old stellar population. 8 μm images denote the gas and dust lanes; hence they are usually ascribed with the location of the underlying density waves. As the initial phase, we create composite images using the different wavelengths and de-project them to a face-on orientation. The standard, Image Reduction and Analysis Facility (IRAF) ellipse fitting tasks are used in the de-projection process while considering the available published de-projection parameters in the NASA/IPAC Extragalactic Database (NED). The arm-inter-arm contrast plots require an additional symmetry enhancement process to better visualize the underlying symmetry. The most probable locations for the co-rotation radii were identified using each method and were compared against previous studies found in the literature. Most of the results are compatible, while there are a few galaxies with notable deviations. Considering each galaxy and the results obtained through each method, the largest sample standard deviation of s = 1.5 kpc is recorded for NGC 1566, while the smallest, s = 0.31 kpc is recorded for NGC 5194. NGC 3031 shows the largest deviation when comparing our results with the values found in the literature. To better understand the deviations, further analysis is required using larger sample sizes and more wavelengths.

Keywords: Co-rotation radius, Resonance locations, Spiral galaxies