Uncertainties in the Deprojection of The Observed Bar Properties

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Deprojecting the observed properties of bars to face-on values is an important step before any careful analyses. However, systematic estimation on the uncertainties of the commonly used deprojection methods is still lacking. We use simple but realistic simulated barred galaxies to investigate this problem. The 3D simulations are projected onto a 2D plane with different bar direction and inclination angles. We measure the bar properties, i.e., bar length and ellipticity, with several different methods. The measured results are then deprojected to the face-on values with the popular deprojection methods in the literature. We evaluate the uncertainties by comparing the deprojected results with the values directly extracted from the face-on images. Generally speaking, given an inclination angle, 2D deprojection methods (analytical and image deprojection) are more precise than 1D analytical deprojection method. Among all the methods tested here, Fourier decomposition method produces the most accurate deprojected bar length ($\sim 5\%$ uncertainty). However, all the deprojection methods start to fail when the inclination angle is larger than 60°, because the basic assumption, that the bar is infinitely thin, becomes invalid at large inclination angles. We construct a toy model of the bar to investigate the effect of the thickness on the uncertainty in the deprojection process. The toy model reproduces the results of the 1D and 2D analytical deprojections very well. It also confirms that the thickness of the bar is the main source of uncertainties.