概要： 渦巻銀河はなぜ渦を巻いている？ 密度波理論は正しい？どうも密度波が予測するような星形成領域の腕をしているように観測は示している。
ゴール：渦巻銀河がなぜ渦を巻くか理解しよう。
オリジナリティ：一周回って良い質問になったらしい。
ロジック：活字を書く暇がないので言葉で説明します…。
コメント：そもそも密度波とは何で、なぜできるのか？

ON THE SPIRAL STRUCTURE OF DISK GALAXIES

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ABSTRACT

It is shown that gravitational instability is a plausible basis for the formation of the spiral pattern in disk galaxies An explicit asymptotic formula is obtained for the form of the spiral. It gives reasonable numerical results for the galaxy, and qualitatively satisfactory trends for normal spirals of various types.

Lin and Shu,1964, ApJ, 140, 646

Getting et al. 2004, MNRAS, 349, 909

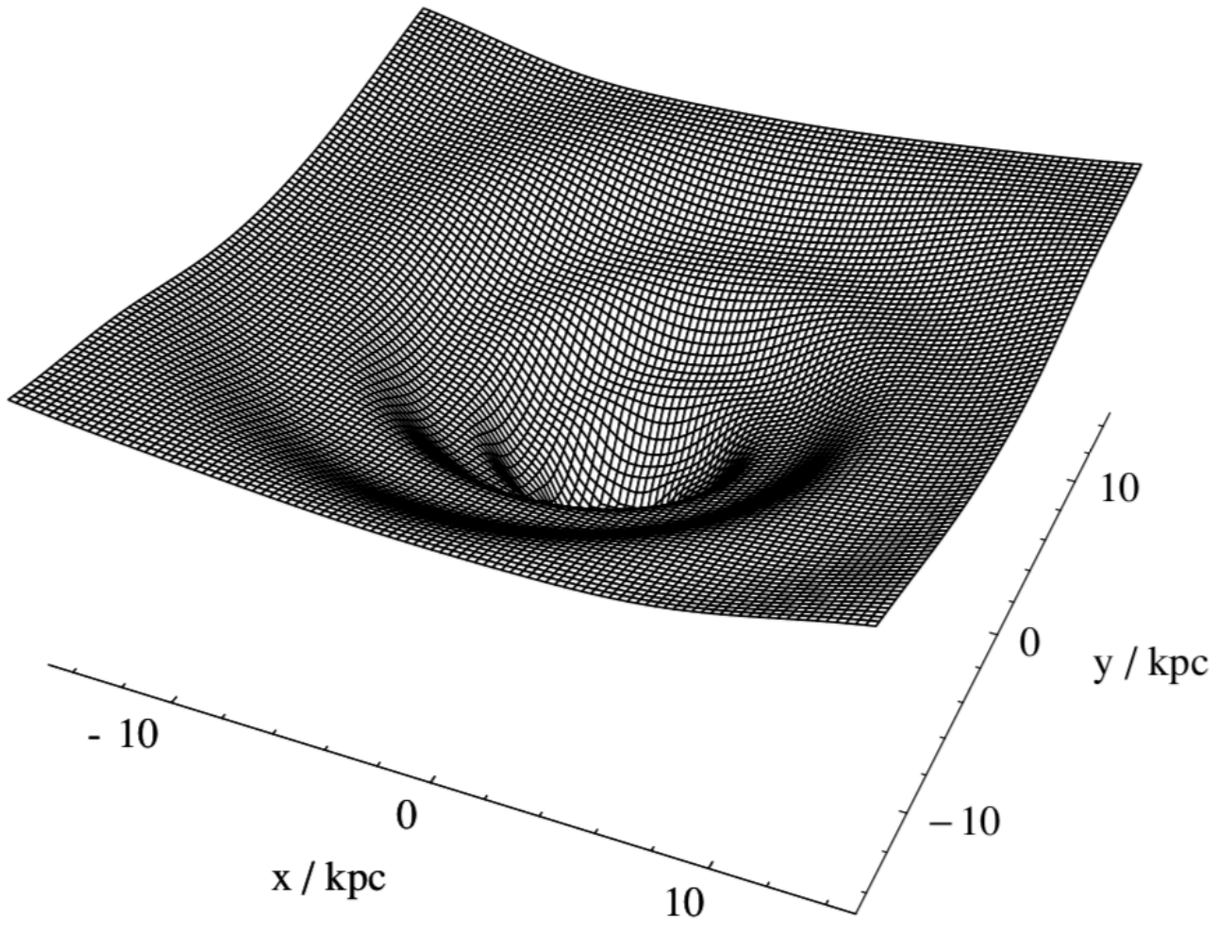


Figure 1. Potential surface with parameters $F_{\rm b} = 0$, $\epsilon_{\rm d}^{-1} = 1.5$ kpc, $\epsilon_{\rm s}^{-1} = 10$ kpc, $\sin i = 0.2$, $m = 2$ and $F_0 = .6$ at $R_0 = 8.5$ kpc. A very high value of F is chosen to produce a spiral perturbation visible on this figure.

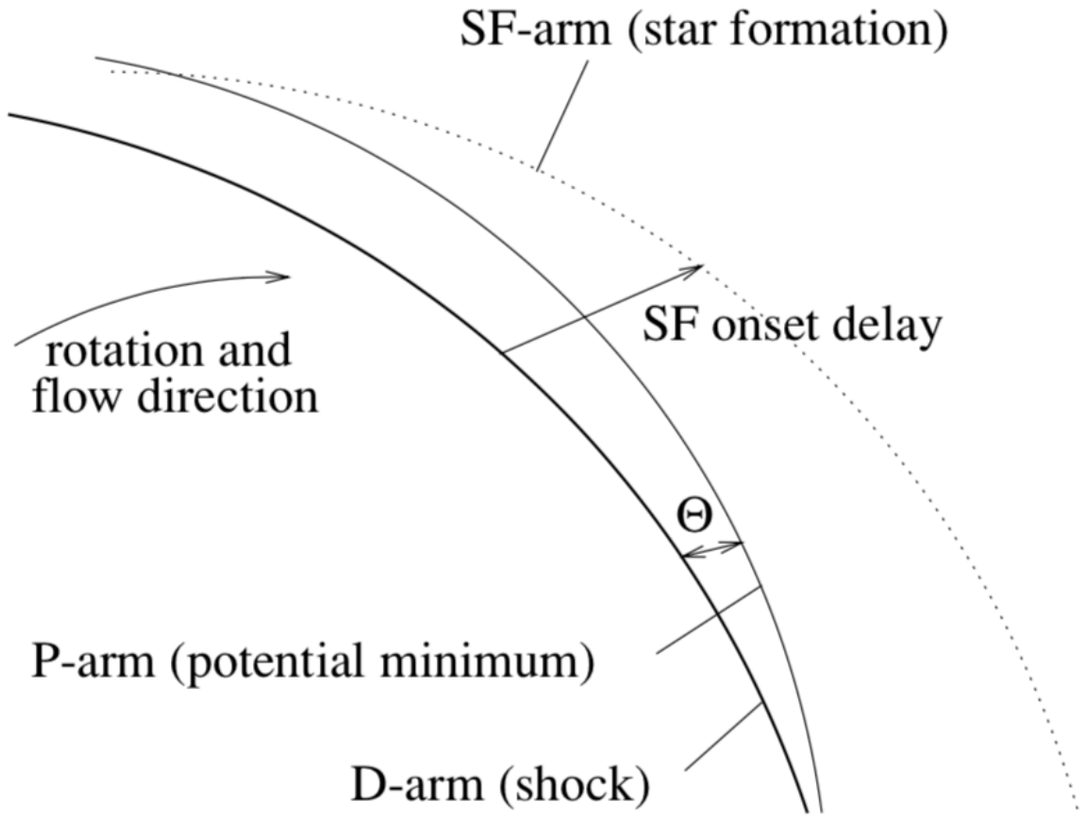


Figure 16. Diagram of the three types of spiral arm and their separations. In this diagram Θ becomes more negative with radius, so that the D-arm is more tightly wound than the P-arm. The star formation time-delay is constant, but because the relative velocity of the gas to the P-arm is smaller at larger radii, the angular delay is smaller. Consequently the SF-arm is more tightly wound than the D-arm.

Yu et al. 2018 ApJ, 862, 13

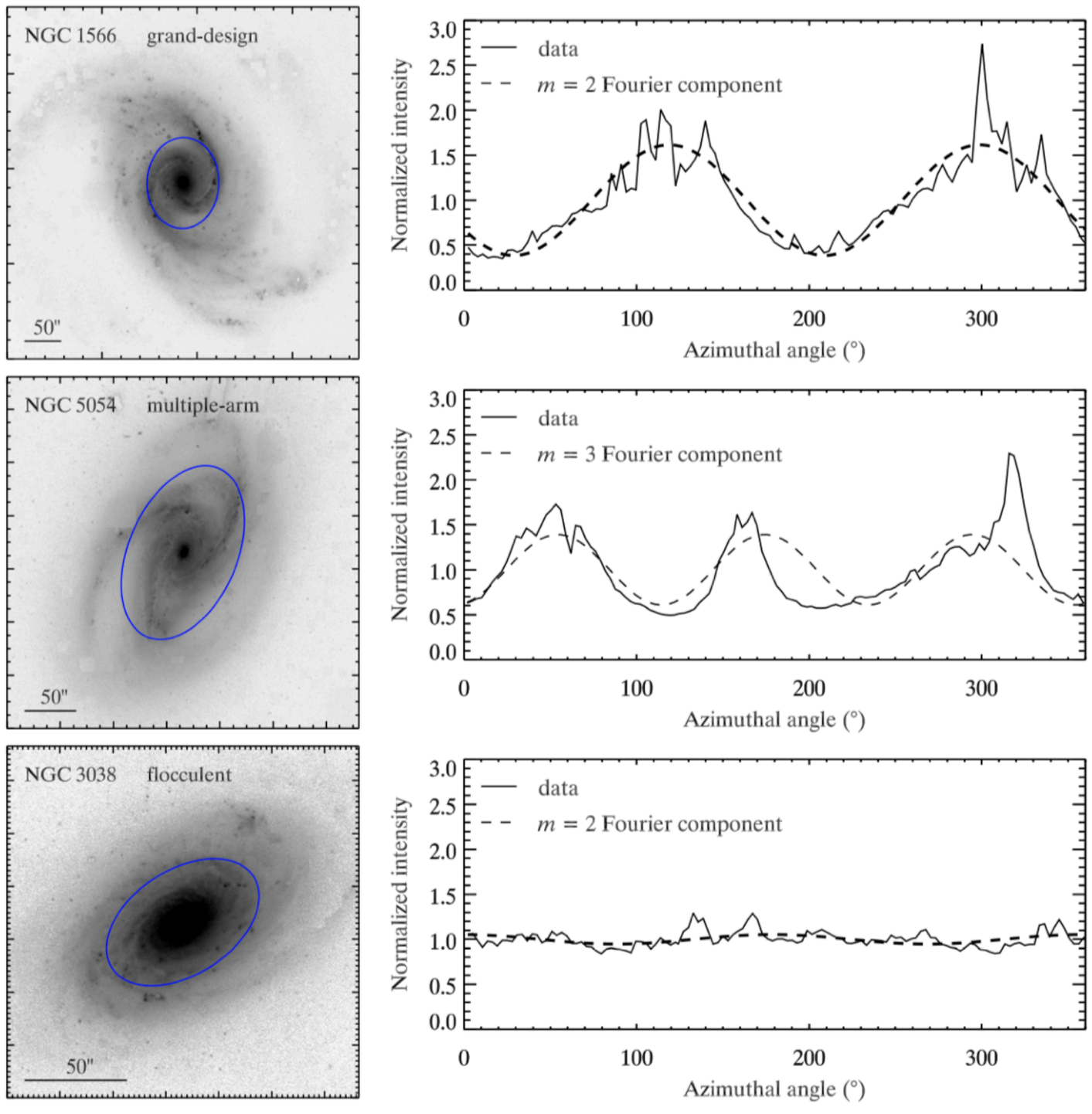


Figure 2. Illustration of the three main categories of spiral galaxies: (top row) grand-design galaxy NGC 1566, (middle row) multiple-armed galaxy NGC 5054, and (bottom row) flocculent galaxy NGC 3038. The images are oriented with north to the top and east to the left; a scale of 50″ is given in the bottom-left corner of each image. The left column shows the *R*-band CGS image. The blue ellipse denotes the isophote with which we extract the normalized azimuthal intensity profile in the right column. The dashed line represents the best-fit dominant Fourier mode.

Yu and Ho et al. 2018 (arxiv:1810.08979)

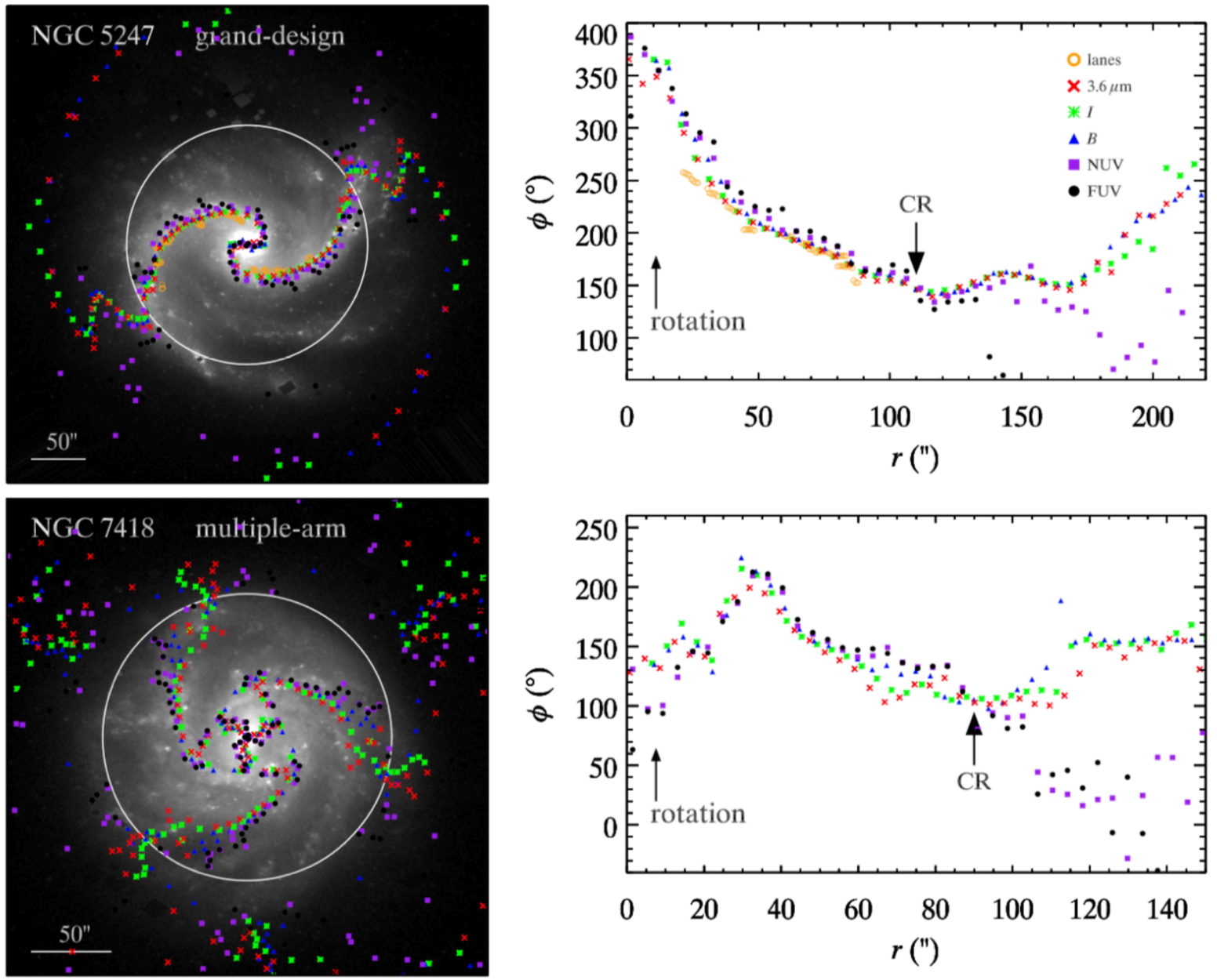


Figure 1. Results of 1D Fourier decomposition for NGC 5247 (upper row) and NGC 7418 (bottom row). Left panels present the CGS *B*-band images, overplotted with the resulting centroids of the spiral arms, with their polar coordinate shown in the right panels, in 3.6 μm (red crosses), *I* (green stars), *B* (blue triangles), NUV (purple squares), and FUV (black points). Right panels show the phase angles of spiral arms, identified by the 1DDFT method, as a function of galactocentric radii. We adopt the convention that the azimuthal angle increases with rotation. The orange symbols, if available, represent the dust lanes, identified visually in the *B*-band images. The white circles in the left panels indicate the estimated corotation radius (CR), at which location the color gradient reverses; the arrow in the bottom left corner of the right panels denotes the direction of rotation.

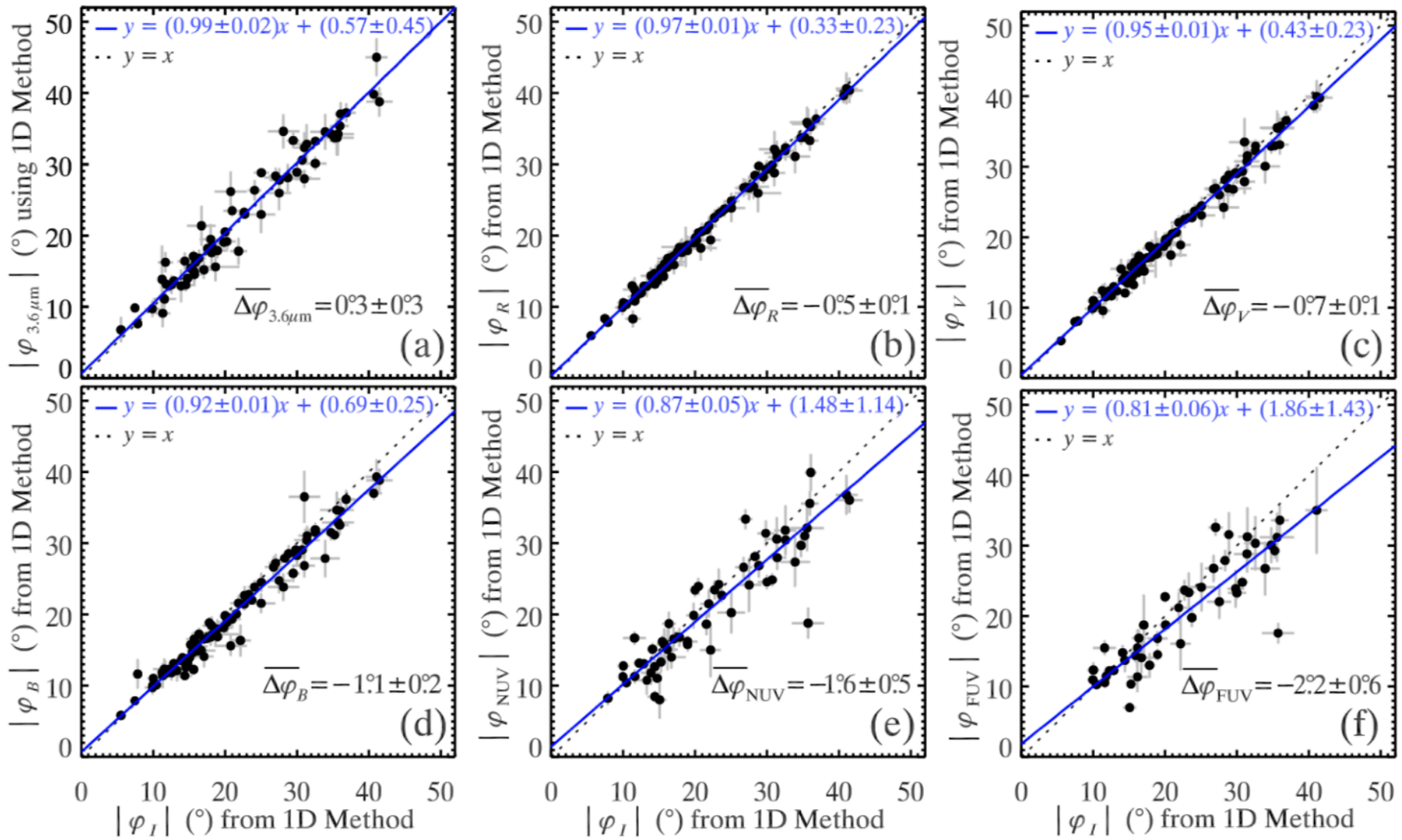


Figure 3. Correlations between the pitch angle of spiral arms, calculated from the 1D method, in the I band and in the (a) 3.6 μm, (b) R, (c) V, (d) B, (e) NUV, and (f) FUV bands. In each panel, the dashed black line marks the 1:1 relation, and the blue solid line is the best-fit straight line. The mean difference, $\overline{\Delta\varphi}$, and its error are given in the bottom-right corner of each panel.

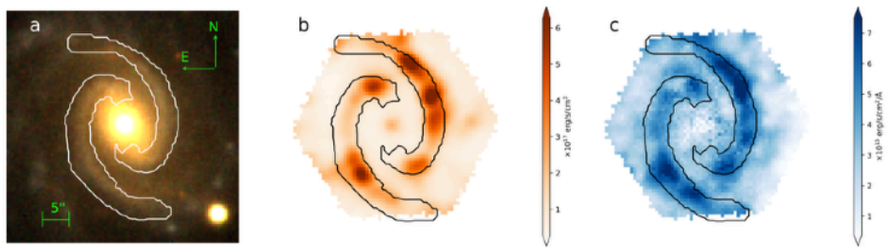


Figure 1: UGC 3825. *Left*: SDSS imagery[21]. *Centre*: Ongoing star-formation, traced by the Hydrogen-α emission line. *Right*: contribution of young stars. The outline denotes the region within which at least 25% of GZ:3D users agreed on the presence of a spiral arm.

Peterken et al. 2018 Nature submitted (arXiv:1809.08048)