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OBSERVATIONAL EVIDENCE AGAINST LONG-LIVED SPIRAL ARMS IN GALAXIES

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ABSTRACT

We test whether the spiral patterns apparent in many large disk galaxies should be thought of as dynamical features that are stationary in a corotating frame for $\gtrsim t_{\rm dyn}$, as implied by the density wave approach for explaining spiral arms. If such spiral arms have enhanced star formation (SF), observational tracers for different stages of the SF sequence should show a spatial ordering, from upstream to downstream in the corotating frame: dense H I, CO, tracing molecular hydrogen gas, 24 μm emission tracing enshrouded SF, and UV emission tracing unobscured young stars. We argue that such a spatial ordering should be reflected in the angular cross-correlation (CC, in polar coordinates) using all azimuthal positions among pairs of these tracers; the peak of the CC should be offset from zero, in different directions inside and outside the corotation radius. Recent spiral SF simulations by Dobbs & Pringle show explicitly that for the case of a stationary spiral arm potential such angular offsets between gas and young stars of differing ages should be observable as cross-correlation offsets. We calculate the angular cross-correlations for different observational SF sequence tracers in 12 nearby spiral galaxies, drawing on a data set with high-quality maps of the neutral gas (H I, THINGS) and molecular gas (CO, HERACLES), along with 24 μm emission (*Spitzer*, SINGS); we include FUV images (*GALEX*) and 3.6 μm emission (*Spitzer*, IRAC) for some galaxies, tracing aging stars and longer timescales. In none of the resulting tracer cross-correlations for this sample do we find systematic angular offsets, which would be expected for a stationary dynamical spiral pattern of well-defined pattern speed. This result indicates that spiral density waves in their simplest form are not an important aspect of explaining spirals in large disk galaxies.