POSSIBLE EVIDENCE FOR LIN'S THREE-WAVE INTERACTION MECHANISM AT COROTATION IN THE GALAXY NGC 1566

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In a previous paper, (Comte and Duquennoy, 1982), we have reported observations of the distribution and kinematics of the ionized hydrogen in the large southern spiral NGC 1566 (SAB(r?s)bc I). We found evidence for a severe warping of the galactic disk, and discussed the spiral distribution of 477 detected HII regions. The *observed* spiral structure, deduced from the positions of the regions deprojected in a ($\ell n\ r$, θ) diagram, shows a four-armed design (Fig. 1):

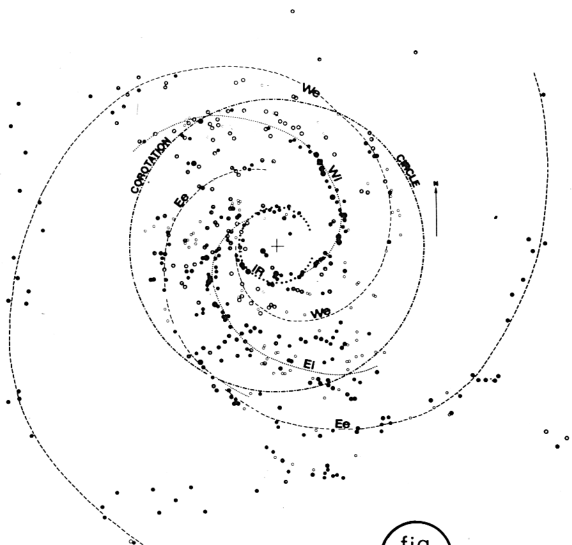

fig. 1

- 2 "principal, inner" arms (WI and EI on Fig. 1), containing very bright HII regions, with pitch angle 28°, finishing abruptly near $r \simeq 130''$.
- 2 "outer" arms, fainter in Hα, of pitch angle 15° till $r = 130''$ then opening slightly to 20°, winding away around the galaxy into a "pseudo-outer-ring". (WE and EE on Fig. 1).
- An uncomplete inner ring located at $r \simeq 35''$.

From a preliminary velocity field obtained by means of Hα Fabry-Perot interferometry, a rotation curve was drawn and fitted by a simple two-populations (bulge + disk) mass model, based on de Vaucouleurs' (1973) surface photometry and the method described by Monnet and Simien (1977). Possible non-circular velocities exist near the inner ring zone.

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The model rotation curve was used to derive the angular velocity Ω, the epicyclic frequency κ and the quantities $\Omega \pm \kappa/2$ (Fig. 2).

The possible existence of spiral waves of different pitch angle in a same pattern (i.e. rotating with a unique velocity Ωp), was suggested first by Lin (1969) as a natural replenishment mechanism of the spiral through 3-wave interaction at corotation: a *long* (*open* spiral) wave interacts with two *short* (tight spiral) waves; detailed calculations were made by Mark (1976). In NGC 1566, we may locate the corotation zone at r = 130" where the main inner open spiral vanishes. This gives $17.5 < \Omega p < 19$ km s^{-1} kpc^{-1} for Δ = 15.3 Mpc; the inner Lindblad resonance (ILR) is then just inside the inner ring and the outer resonance at 300" < r < 350". (The outermost HII region is observed at r = 325"). Using the Lin-Shu-Toomre dispersion equation for density waves, we compute two wavenumbers which lead one to the tight spiral, the other to the open spiral (dotted and dashed lines on Fig. 3). The agreement with the observed pitch angles is good for 4.5 < r < 7.5 kpc.

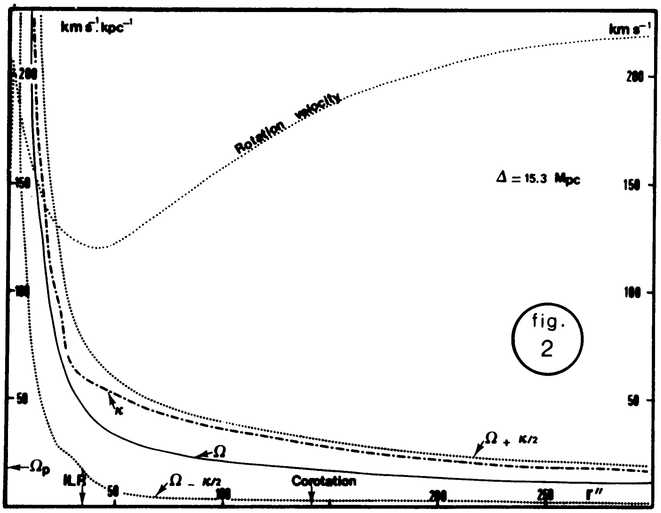

fig. 2

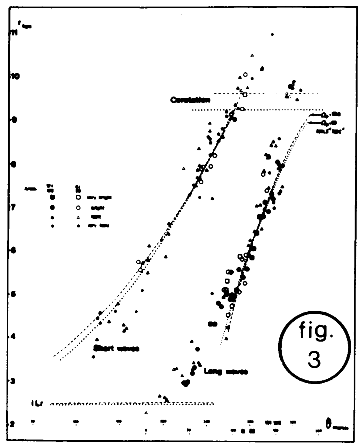

fig. 3

From Mark's calculations, the short wave should be amplified with respect to the long one, in terms of carried angular momentum. We observe a high-contrast long wave, and a low-contrast short wave in terms of stellar formation. However, computation of $w_{\perp o} = (\Omega - \Omega p) r \sin i$ for both waves shows (Roberts, 1969) that a shock may be generated at the front of the long wave, with subsequent triggering of stellar formation (supersonic flow of gas), but is likely to be unimportant at the front of the short wave.

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