THEORY AND SPH SIMULATION OF ULTRAHARMONIC RESONANCES IN GASEOUS GALACTIC DISKS

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ABSTRACT. Some regular 2-armed spiral galaxies (e.g. M81, M100) reveal also local 4-armed features, especially close to the radius of UHR (ultraharmonic, or 4:1 resonance). They may at least partially originate in gasous disk component. We performed some SPH (smoothed particle hydrodynamics) simulations of a model gas disk perturbed by the harmonic (2-armed) perturbation potential representing the gravity of the stellar arms. SPH calculations produce the inter-arms near the UHR due to non-linear dynamical effects. They can be interpreted as the first wavelength of a viscously damped density wave originating at UHR. We present elswhere (Artymowicz, 1990; Artymowicz and Lubow, 1990) an analytical slightly non-linear theory of harmonic and ultraharmonic wave launching, propagation and dissipation in gaseous disks with arbitrary soundspeed, self-gravity and viscosity, in the perturbing gravitational potential of arbitrary form. The main conclusions are as follows:
(i) The physics of wave generation at UHR and the Lindblad resonances is similar. The total torque exerted on the disk by the external potential is practically independent of the amount of viscosity and self-gravitation in both cases.
(ii) The total torque depends sensitively on the disk's rotation curve and the tightness of the imposed spiral structure.
(iii) Applied to M81, the theory including linear and quadratic terms predicts a large and hence observable amplitude of the 4-armed waves at UHR, consistent with the recent observational work of Elmegreen et al. (1989).
(iv) Transfer of negative angular momentum from the stellar to the gaseous disk results in a significant damping of the stellar wave. Direct conversion of the harmonic to ultraharmonic *stellar* wave at UHR may be even more efficient.
(v) We propose that UHR plays a major role in limiting the global instabilities (e.g. of SWING or WASER-type) in M81 and presumably many other spirals.

REFERENCES

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