OSCILLATION OF A STELLAR SYSTEM WITH A CENTRAL MASSIVE OBJECT

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1. Introduction

We investigated the oscillation of a dense stellar system which harbours a massive object, presumably a supermassive black hole, in its center. The central mass moves in response to the oscillation of the stellar system. This phenomenon may explain the asymmetric structure observed in M31 (Lauer *et al.*, 1993), or NGC4486B (Lauer *et al.*, 1996). Moreover, the motion of the central massive black hole may well induce the accretion of gas onto the black hole itself and ignite the activity in galactic nuclei. We first investigated the stability of a fluid disk around a massive object by linear modal analysis. Next, we performed N-body simulations for spherically symmetric, rotating, particle systems with a central mass.

2. Results

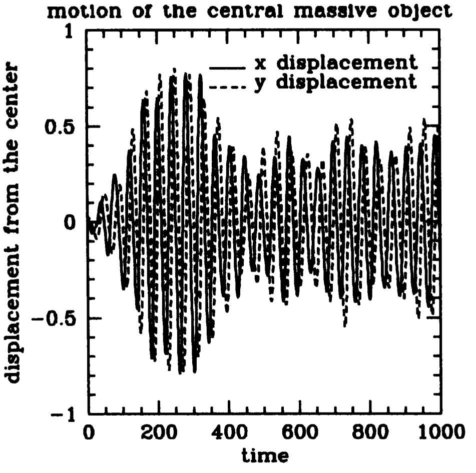
In the table of the next page we show the growth rate of unstable modes with angular wavenumber $m = 1$ on a fluid disk that has a massive object at the center. M_{CM}/M_{disk} is the ratio of the mass of the central object to the mass of the disk, h is the hotness parameter which measures the temperature of the disk (high temperature for high value of h). The third column is the growth rate of the unstable mode, for which the central mass is allowed to move away from the center of the disk. The fourth column is the corresponding growth rate of the unstable mode for the same equilibrium models, for which the central mass is not allowed to move, but is fixed at the center. In the absence of the motion of the central mass, the disk is stable to $m = 1$ Jeans instability if the temperature of the disk is high enough. However, the disk becomes unstable if the motion of the central

Y. Sofue (ed.), The Central Regions of the Galaxy and Galaxies, 79-80.

mass is allowed. Adams *et al.* (1989) and Shu *et al.* (1990) called this kind of instability as "eccentric instability" and studied it in the context of the stability of a disk around a young stellar object. The interaction between the central mass and the disk is expected to play a crucial role in this kind of instability.

Next, we investigated the motion of the central mass in a spherically symmetric, rotating stellar system by N-body simulations. The result is displayed in the figure below. The mass of the central object is 1% of the surrounding stellar system. One can see that the central mass promptly displaces from the center and rotates around the center of mass. This motion continues long, because the central mass moves with the rotation of the surrounding stellar system and the effect of dynamical friction is negligible. This sort of motion is reported by Miller & Smith (1992, 1994) as core wandering phenomenon. Therefore, the instability that was observed in a fluid disk is also expected to appear on the stellar system. This instability can be a mechanism of gas fueling into the supermassive black hole in the center of active galactic nuclei.

$\frac{M_{CM}}{M_{disk}}$	h	$\hat{\omega}$	$\hat{\omega}_{fixed}$
0.01	0.1	1.39	1.39
	0.5	0.13	0.13
	1.0	0.39	—
0.05	0.1	1.00	1.01
	0.5	0.16	0.16
	1.0	0.39	—
0.1	0.1	0.80	0.80
	0.5	0.14	0.14
	1.0	0.39	—
0.2	0.1	0.54	0.54
	0.5	0.11	0.11
	1.0	0.39	—



References

Adams, F. C., Ruden, S. P., & Shu, F. H. 1989, ApJ, 347, 959
Lauer, T. R. et al. 1993, AJ, 106, 1436
Lauer, T. R., Tremaine, S., Ajhar, E. a., Bender, R., Dressler, A., Faber, S. M., Gebhardt, K., Grillmair, C. J., Kormendy, J., & Richstone, D. 1996, ApJ, 471, L79
Miller, R. H. & Smith, B. H. 1992, ApJ, 393, 508
—. 1994, Celest. Mech., 59, 161
Shu, F. H., Tremaine, S., Adams, F. C., & Ruden, S. P. 1990, ApJ, 358, 495