A NEW DRIVING MECHANISM OF THE EPISODIC MASS-LOSS IN BE STARS

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Be stars are well known to be rapid rotator and to show intermittent emission-line activity. Such an activity is now interpreted as an abrupt mass-ejection and formation of a cool disk in the equatorial region and then its gradual disappearance on a time scale of several years to some decades. This intermittent mass-loss is called as episodic mass-loss.

Rapid rotation and mass-loss connection in Be stars was suggested for the first time by Struve(1931), which necessarily leads to the requirement of break-up velocity in Be stars. However, Vsin i statistics suggests almost all Be stars are well below the break-up velocity. The additional forces have been searched for so far; i.e., stellar wind, magnetic field, mass accretion, and so on. At the moment, none of them can succeed in explaining the episodic mass-loss in Be stars.

The very accurate spectroscopy by the solid state detectors have led to the discovery of the line profile variations in Be stars on a time scale of several hours to day. Such variations are considered due to nonradial pulsations(NRPs)(see Baade 1987), of which nature is correlated with Be emission activity. Mass-ejection driven by NRPs like radial pulsation was suspected by Willson(1986). But the quasi-periodicity of mass-loss cannot be explained naturally by this mechanism.

We propose a new driving mechanism of quasi-periodic mass-loss by NRPs. The observed NRPs being nonaxisymmetric modes, these modes can transport angular momentum from place to place. At the dissipative region near the surface, a prograde mode can accelerate the rotation, while a retrograde mode can decelerate the rotation (see Ando 1983). Observations show that retrograde modes are found when Vsin i of a Be star is larger than 170 km/s, and otherwise prograde modes. We presume this rule can be resulted from wave-rotation interaction even though a prograde and a retrograde mode are excited at a time.

In the presence of a prograde and a retrograde mode with equal characteristics, the rotation at the surface region is neither accelerated nor decelerated, and is in uniform rotation in a zero-th order. Is this state stable? If the rotation profile is perturbed towards acceleration, intrinsic frequency (seen from rotating frame) of a pro-

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grade mode decreases and that of a retrograde mode increases. When this situation causes the increase of the accelerating effect of a prograde mode and the reduction of the decelerating effect of a retrograde mode, the rotation profile can be accelerated further more. Otherwise uniform rotation is stable.

We will explain this physical meaning. If the inverse of intrinsic frequency of a mode, that is, dynamical time scale is increased, the corresponding region to the efficient radiation loss moves inwards. So the temperature increases, and the opacity is decreased, if it is Kramers' type opacity, which leads to the increase in radiation loss. According to Ando(1983), the increase in radiation loss leads to the increase both of the acceleration of a prograde mode and of the deceleration of a retrograde mode. Therefore, the rotation profile is unstable in this case. When H^- opacity is dominant, the situation is contrary and the rotation profile is stable. So it is concluded that in the early type stars the uniform rotation is unstable in the presence of a prograde and a retrograde mode, while in the late type stars it is stable.

In Be stars, the uniform rotation have been shown to be unstable in the presence of a prograde and a retrograde mode. Ultimately their rotation profile has been pointed out by Ando(1986) to oscillate quasi-periodically around the uniform rotation (see Ando(1986) for the detailed explanation of the oscillatory behavior of the rotation profile).

From our calculations of wave-rotation interaction, we can summarize the two important aspects of this mechanism of episodic mass-loss.

1. Acceleration of rotation speed is, roughly speaking, wave pattern (phase) speed (20-100km/s), which is enough to enforce the equatorial rotation velocity to reach its break-up velocity.
2. this mechanism can explain the quasi-periodicity of episodic mass-loss quite naturally. Our calculations show its time scale is 1 to 15 years, although it is a little shorter.

The observational test for a new mechanism may also be derived.

A. Quasi-periodic variation of Vsin i should be observed in accordance with episodic mass-loss.

B. There should be an anti-correlation of amplitude or of appearance of NRPs with Be emission activity.

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