N26b Transonic Decretion Disks around Be Stars

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We consider the structure of the outflow in disks of Be stars, based on the viscous decretion disk scenario. In this scenario, the matter ejected from the star with the Keplerian velocity at the equatorial surface of the star drifts outward because of the effects of viscosity, and forms the disk. For simplicity, we adopt the α-description for the viscous stress, and assume the disk to be isothermal. We find that a transonic solution of decretion exists for a disk around a Be star. The sonic point is located at $r > 100R_*$ where R_* is the stellar radius. The sonic radius is smaller for higher temperature and/or larger radiative force. We also find that the topology of the sonic point is nodal for $\alpha \gtrsim 0.95$, while it is saddle type for $\alpha \lesssim 0.9$. According to the theory of transonic accretion, the sonic point in the former case is unstable, while that in the latter case is stable. The outflow is highly subsonic in the inner part of decretion disks. In the subsonic region, the outflow velocity increases as r and the surface density decreases as r^{-2}. The angular velocity of the disk decreases as $r^{-1/2}$ in the inner subsonic region, while it decreases as r^{-1} in the outer subsonic region and the supersonic region. Our results, together with the observed range of the base density for Be star disks, suggest that the mass loss rate in the equatorial region is at most comparable with that in the polar region.

The decretion disks are, in general, overstable for the $m = 1$ modes because of the viscous effect. Some examples of $m = 1$ eigenmodes confined to the inner part of the transonic decretion disks are presented.