Accretion disks around young stars produce excess infrared continuum associated with the disk, and excess optical and ultraviolet continua associated with the boundary layer or "hot spot" as material falls from the disk onto the stellar photosphere. When we subtract the excess continuum and photospheric contributions to the total spectrum, we can obtain high-quality emission line profiles of the Balmer lines as well as permitted lines from other elements. These emission lines often exhibit redshifted absorption, indicative of infalling material. Remarkably, objects with large accretion rates tend to rotate slower than their counterparts that lack accretion disks. Hence, there must be some process, probably involving magnetic fields, that allows the star to accrete large amounts of material from the disk without increasing its rotational velocity. Young stars typically do not have optically thick inner disks that do not accrete. Hence, either planets form within accretion disks, or the timescale for planetary formation is considerably shorter than \( 3 \times 10^{6} \) yr, the duration of the classical T Tauri star phase of young stellar evolution.

The disk instability model can explain the previous history of dwarf-nova-like outbursts in the intermediate polar GK Per, which occur about once every three years. Disk models that reproduce the recurrence time and outburst light curves suggest that GK Per has a large effective inner disk radius (30-40 white dwarf radii) truncated by a strong magnetic field (10^7 G). In this context, the disk instability model can explain the outburst and the decay of the inner hot disk and reflected radiation from a corona or other structure above the disk. Two plausible mechanisms of irradiation of the disk are considered: direct irradiation from the inner hot disk and reflected radiation from a corona or other structure above the disk. Both of these processes will be time dependent in the context of the disk instability model and result in more complex time-dependent behavior of the disk structure. We test both disk instability and mass transfer models for the physical states of the disk in the presence of irradiation.

We study the disk instability and the effect of irradiation on outbursts in the black hole X-ray nova systems. In both the optical and soft X-rays, the light curves of several X-ray novae, AO620-00, GS2000+25, Nova Muscae 1991 (GS1124-68), and GRO J0422+32, show a main peak, a phase of exponential decline, a secondary maximum or reflare, and a final bump in the late decay followed by a rapid decline. Basic disk thermal limit cycle instabilities can account for the rapid rise and overall decline, but not the reflare and final bump. The rise time of the reflare, about 10 days, is too short to represent a viscous time, so this event is unlikely to be due to increased mass flow from the companion star. We explore the possibility that irradiation by X-rays produced in the inner disk can produce these secondary effects by enhancing the mass flow rate within the disk. We expect the possibility that irradiation by X-rays produced in the inner disk can produce these secondary effects by enhancing the mass flow rate within the disk. Two plausible mechanisms of irradiation of the disk are considered: direct irradiation from the inner hot disk and reflected radiation from a corona or other structure above the disk. Both of these processes will be time dependent in the context of the disk instability model and result in more complex time-dependent behavior of the disk structure. We test both disk instability and mass transfer models for the physical states of the disk in the presence of irradiation.

We study the properties of coupled partial differential equations describing the time-dependent behavior of the photon and electron occupation numbers for conditions likely to be found near active galactic nuclei (AGN). The processes governing electron acceleration are modeled by a stochastic accelerator, and we include acceleration by Alfvenic and whistler turbulence. The acceleration of electrons is limited by Compton and synchrotron losses and the number density of electrons depends on pair production and annihilation processes. We treat particle escape from the system. We also treat particle escape from the system. We examine the steady, (possibly) oscillatory, and unstable solutions that arise for various choices of parameters. We examine instabilities related to pair production and trapping as proposed by Henri and Pelletier and consider the formation of pair jets.


We review the empirical constraints on accretion disk models of stellar-mass black holes based on recent multiwavelength observational results. In addition to time-averaged emission spectra, the time evolutions of the intensity and spectrum provide critical infor-
We construct evolutionary scenarios for LMXBs using a simplified stellar model. We discuss the origin and evolution of short-period, low mass binary pulsars with evaporating companions. We suggest that these systems descend from low-mass X-ray binaries and that angular momentum loss mainly due to evaporative wind drives their evolution. We derive limits on the energy and angular momentum carried away by the wind based on the observed low eccentricity. In our model the companion remains close to contact and its quasidiabatic expansion causes the binary to expand. Short-term oscillations of the orbital period may occur if the Roche-lobe overflow forms an evaporating disk.

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There has been, recently, a revival of the stability problem of accretion disks. Much of this renewed interest is due to recent observational data on transient soft X-ray novae, which are low-mass X-ray binaries. It is widely believed that nonsteady mass transfer from the secondary onto the compact primary, through an accretion disk, is the reason for the observed spectacular events in the form of often repetitive outbursts, with recurrence times ranging from 1 to 60 yr and duration time on the scale of months. Though not having reached yet a consensus about the nature of the mechanisms that regulates the mass transfer, the disk thermal instability model [1-4] seems to be favored by the fact that the rise in the hard X-ray luminosity is prior to the rise in the soft X-ray luminosity, while the mass transfer instability model [5-7] seems to be hindered by the fact that the luminosity during quiescence is unable to trigger the thermal instability. However, it should be stressed that, remarkably, the X-ray light curves of these X-ray novae all show overall exponential decays ($t_{\text{d}} = \exp(-\mu t)$), a feature quite difficult to reproduce in the framework of the viscous disk model, which yields powerlike luminosity decay. Taking into account this observational constraint, we have studied the temporal evolution of perturbations in the accretion rate, under the assumption that $\alpha$ is radial and parameter dependent. The chosen dependence is such that the model can produce limit cycle behavior (the system is locally unstable but globally stable). However, the kind of dependence we are looking for in $\alpha$ does not allow us to use the usual Shakura and Sunyaev procedure in the sense that we no longer can obtain a linearized continuity equation without explicit dependence on the accretion rate. This is so because now we cannot eliminate the accretion rate by using the angular momentum conservation equation. In other words, the stress now depends upon the surface density, the scale height of the disk, and the accretion rate. If we write the viscosity parameter as

$$\alpha = \alpha_0 \phi$$

where we have included the $r$-dependence in $\alpha_0$ and the parameter dependence in $\phi$, we obtain the linearized angular momentum conservation equation

$$\frac{\delta \phi}{\phi} = \frac{4}{3} \frac{\partial}{\partial \phi} \left( \frac{8M}{M_0} + u + 2h \right)$$

the linearized continuity equation

$$\frac{\partial}{\partial \phi} \left( \frac{\delta \phi}{\phi} \right) = \frac{1}{2nR} \frac{\partial}{\partial R} \delta M$$

and the linearized energy equation

$$\frac{1}{2} \left( 5 + 18\beta_0 + 9\beta_0^2 \right) \frac{\partial}{\partial \phi} \left( u + 2h - \frac{\delta \phi}{\phi} \right) =$$

$$\frac{2}{3} \left( 5 + 18\beta_0 + 9\beta_0^2 \right) \alpha_0 \Omega_0 \frac{\partial}{\partial \phi} \left( u + 2h - \frac{\delta \phi}{\phi} \right) +$$

$$3\alpha_0 \Omega \left[ 2 (1 + \beta_0) u + 2 (5\beta_0 - 3) h - \frac{\delta \phi}{\phi} \right]$$