OBSERVATIONS OF ACCRETION AND ANGULAR MOMENTUM REGULATION IN YOUNG CIRCUMSTELLAR DISKS AND THE IMPLICATIONS FOR PLANETARY FORMATION. P. Hartigan. University of Massachusetts, Amherst MA 01003, USA.

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 act to balance the effects of rotation and the forces exerted on material falling from the disk. We will discuss the implications of the observations for the structure and evolution of circumstellar disks around young stars.

DISK IRRADIATION AND LIGHT CURVES OF X-RAY NOVAE. S.-W. Kim1, J. C. Wheeler1, and S. Mineshige2. Department of Astronomy, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA. 1Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA. 2Physics Department, Catholic University of America, Washington DC 20064, USA.

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-ray bands, the light curves of several X-ray novae, AX 2014, 1O 606-01, and GS 2000+25, 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. We 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 be consistent with the radiative time scale. In this work, we examine the steady, oscillatory, and outburst behaviors related to pair plasma instability and disk structure. We test both disk instability and mass transfer models for the observed temporal variability in the presence of irradiation.

DISK INSTABILITY AND THE SPECTRAL EVOLUTION OF THE 1992 OUTBURST OF THE INTERMEDIATE POLAR GK PERSEI. S.-W. Kim1, J. C. Wheeler1, F. C. Bruchweiler2, M. Fitzurka2, K. Beuermann3, K. Reinsch3, and S. Mineshige4. 1Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA. 2Physics Department, Catholic University of America, Washington DC 20064, USA. 3Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA. 4Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA.

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 effective radius is that portion of the disk that participates in the disk thermal instability. The radius derived is larger than the corotation radius, which must be an upper limit on the true dynamical inner radius of the disk. Disk instability models with this large effective inner radius predict that the ultraviolet continuum should be rather flat. Here we compare the predictions of the disk instability model to IUE observations of the 1981 outburst and to ROSAT observation of the 1992 outburst of GK Per. The model disk continuum spectral evolution is consistent with the observed UV and optical spectra, especially at maximum and in the early decay phase of the outburst. The consistency of the model with the observed UV spectra suggests that the effective inner radius of the disk is almost constant, independent of mass accretion rate, and that whatever structure lies between the effective inner radius and the corotation radius neither participates in the disk instability nor radiates substantially in the UV. The related physics of the inner disk region will be briefly discussed.

We study the time-dependent behavior of active galactic nuclei with pair production. H. Li1 and C. D. Dermer2. Department of Space Physics and Astronomy, Rice University, Houston TX 77251, USA. 1Department of Space Physics and Astronomy, Rice University, Houston TX 77251, USA. 2Department of Physics, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA.

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 Alfvénic 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 also treat particle escape from the system. We examine the steady, 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 (I) and consider the formation of pair jets.


OBSERVATIONAL CONSTRAINTS ON BLACK HOLE ACCRETION DISKS. E. P. Liang. Department of Space Physics and Astronomy, Rice University, Houston TX 77215-1892, USA.

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-
mation about the structure, stability, and dynamics of the disk. Using the basic thermal Keplerian disk paradigm, we consider in particular generalizations of the standard optically thin disk models needed to accommodate the extremely rich variety of dynamical phenomena exhibited by black hole candidates, ranging from flares of electron-positron annihilations and quasiperiodic oscillations in the X-ray intensity to X-ray nova activity. These in turn provide probes of the disk structure and global geometry. The goal is to construct a single unified framework to interpret a large variety of black hole phenomena. This paper will concentrate on the interface between basic theory and observational data modeling.

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NONLINEAR CALCULATIONS OF THE TIME EVOLUTION OF BLACK HOLE ACCRETION DISKS.

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Based on previous works on black hole accretion disks, I continue to explore the disk dynamics using the finite difference method to solve the highly nonlinear problem of time-dependent alpha disk equations.

Here a radially zoned model is used to develop a computational scheme in order to accommodate functional dependence of the viscosity parameter alpha on the disk scale height and/or surface density. This work is based on the author's previous work on the steady disk structure and the linear analysis of disk dynamics to try to apply to X-ray emissions from black candidates (i.e., multiplayer state spectra, instabilities, QPOs, etc.).

EVOLUTION OF VAPORIZING PULSARS.

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We construct evolutional 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 near 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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CAN A VARIABLE ALPHA INDUCE LIMIT CYCLE BEHAVIOR AND EXPONENTIAL LUMINOSITY DECAY IN TRANSIENT SOFT X-RAY SOURCES?

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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 mechanism 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 (I(t) = exp(−ut)), 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 α is radial and parameter dependent. The chosen dependence is such that the model can reproduce limit cycle behavior (the system is locally unstable but globally stable). However, the kind of dependence we are looking for in α 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

\[ \alpha = \alpha_0 f \]

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

\[ \frac{\delta f}{f_0} = 4 \frac{R}{3} \frac{\partial}{\partial R} \left( \frac{8M}{M_0} + u + 2h \right) \]

the linearized continuity equation

\[ \Sigma_0 \frac{\partial}{\partial t} u = \frac{1}{2\pi R} \frac{\partial}{\partial R} 8M \]

and the linearized energy equation

\[ (8 + 51\beta_0 - 3\beta_0) \frac{\partial}{\partial \gamma} h + 3 \left( 1 + 3\beta_0 + 4\beta_0^2 \right) \frac{\partial}{\partial \gamma} u = \]

\[ \frac{2}{3} (5 + 18\beta_0 + 9\beta_0^2) \alpha_0 \Omega_0 \frac{\partial^2}{\partial R^2} \left( u + 2h - \frac{\delta f}{f_0} \right) + \]

\[ 3\alpha_0 \Omega \left[ 2(1 + \beta_0) u + 2(5\beta_0 - 3) h - \frac{\delta f}{f_0} \right] \]