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56-90 ABS. ONLY

N94-31122

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 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 $\sim 3 \times 10^6$ yr, the duration of the classical T Tauri star phase of young stellar evolution.

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DISK INSTABILITY AND THE SPECTRAL EVOLUTION OF THE 1992 OUTBURST OF THE INTERMEDIATE POLAR GK PERSEI. S.-W. Kim[1], J. C. Wheeler[1], F. C. Bruhweiler[2], M. Fitzurka[2], K. Beuermann[3], K. Reinsch[3], and S. Mineshige[4], [1]Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA, [2]Physics Department, Catholic University of America, Washington DC 20064, USA, [3]Göttingen Universitäs-Sternwarte, Geismarlandstrasse 11, 37083, Göttingen, Germany, [4]Astronomy Department, Kyoto University, Sakyo-ku, Kyoto 606-01, Japan.

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 of the 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 instabilty model to IUE observations of the 1981 outburst and to IUE and ROSAT observation of the recent 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.

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DISK IRRADIATION AND LIGHT CURVES OF X-RAY NOVAE. S.-W. Kim[1], J. C. Wheeler[1], and S. Mineshige[2], [1]Astronomy Department, University of Texas at Austin, RLM 15.308, Austin TX 78712, USA, [2]Astronomy Department, Kyoto University, Sakyo-ku, Kyoto 606-01, Japan.

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, A0620-00, GS 2000+25, Nova Muscae 1991 (GS 1124-68), 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. 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 burst models for the secondary flares in the presence of irradiation. p.1

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N94-31125

TIME-DEPENDENT BEHAVIOR OF ACTIVE GALACTIC NUCLEI WITH PAIR PRODUCTION. H. Li[1] and C. D. Dermer[2], Department of Space Physics and Astronomy, Rice University, Houston TX 77251, USA, [2]Code 7653, Naval Research Laboratory, Washington DC 20375-5352, 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 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 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 [1] and consider the formation of pair jets.

References: [1] Henri G. and Pelletier G. (1991) *Astrophys. J., 383*, L7.

p.2

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N94-31126

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 information 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 novae 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. C. Luo, Department of Space Physics and Astronomy, Rice University, P.O. Box 1892, Houston TX 77251-1892, USA.

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., multiple-state spectra, instabilities, QPOs, etc.).

N94-31128

EVOLUTION OF VAPORIZING PULSARS. P. McCormick, Department of Physics and Astronomy, Louisiana State University, Baton Rouge LA 70803, USA.

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 quasiadiabatic 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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N94-31129

CAN A VARIABLE ALPHA INDUCE LIMIT CYCLE BEHAVIOR AND EXPONENTIAL LUMINOSITY DECAY IN TRANSIENT SOFT X-RAY SOURCES? C. Meirelles Filho and E. P. Liang, Space Physics and Astronomy Department, Rice University, Houston TX 77251, USA.

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 ($L_d \approx \exp -t/t_1$), 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 α_0 and the parameter-dependence in f, we obtain the linearized angular momentum conservation equation

$$\frac{\delta f}{f_0} = \frac{4}{3} R \frac{\partial}{\partial R}\left(-\frac{\delta \dot{M}}{\dot{M}_0} + u + 2h\right)$$

the linearized continuity equation

$$\Sigma_0 \frac{\partial}{\partial t} u = \frac{1}{2\pi R} \frac{\partial}{\partial R} \delta \dot{M}$$

and the linearized energy equation

$$(8 + 51\beta_0 - 3\beta_0^2) \frac{\partial}{\partial t} h + 3\,(1 + 3\beta_0 + 4\beta_0^2) \frac{\partial}{\partial t} u =$$

$$\frac{2}{3}(5 + 18\beta_0 + 9\beta_0^2)\, \alpha_0 \Omega l_0^2 \frac{\partial^2}{\partial R^2}\left(u + 2h - \frac{\delta f}{f_0}\right) +$$

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