vided by cosmic rays and radioactive nuclei. For the purpose of our calculations we assume a solar protoplanetary disk to be an α disk with the opacity law taken from Ruden and Pollack [3] and the ionization state taken from Stepinski [4]. We choose $\alpha = 0.08$, and $\dot{M} = 10^{-6}\,M_\odot$ per year. We assume a disk surrounding a 1-$M_\odot$ star and extending from 0.2 AU up to 40 AU. Figure 2 shows the time evolution of the magnetic field from the initial field $Q(r) = 0.1$ in units of the equipartition value at r = 40 AU. At first the field increases sharply at the inner radii, decays at the middle radii, and remains unchanged at the outer radii. By the time t ≈ 10 yr, the magnetic field in the innermost portion of the disk achieves equilibrium. As time progresses the magnetic field achieves equilibrium at larger and larger portions of the inner disk. At the same time, the field continues to decay at the middle radii, but the decaying region shifts outward as a result of radial diffusion, and the magnetic field in the outer parts starts to show some growth. By the time t ≈ 100 yr the whole region within 3 AU has reached equilibrium. Radial diffusion from the regions of strong magnetic field stops the further decay of the field within the region where the local growth rate is negative, and the field is now actually growing there. The magnetic field in the outer parts of the disk continues to grow. By the time t ≈ 2000 yr, the magnetic field in almost the entire disk has reached equilibrium. Total equilibrium is achieved at roughly t = 4400 yr. The final configuration of the magnetic field follows closely the distribution of the equipartition value magnetic field, except at the middle radii.

Conclusions: The final configuration of a dynamo-generated magnetic field is independent of unknown initial conditions. However, initial conditions influence the way the magnetic field evolves toward its equilibrium, as well as the time needed to achieve such equilibrium. Evolution from initial conditions without field reversals (presented here) leads to an equilibrium field in a time that is very short in comparison with disk viscous time. Evolution from initial conditions with field reversals (not shown here) leads to an equilibrium in a time 10–10^2 times longer, as radial diffusion destroys field reversals. In equilibrium, the field has a magnitude of the order of the equipartition with the kinetic energy of turbulence.

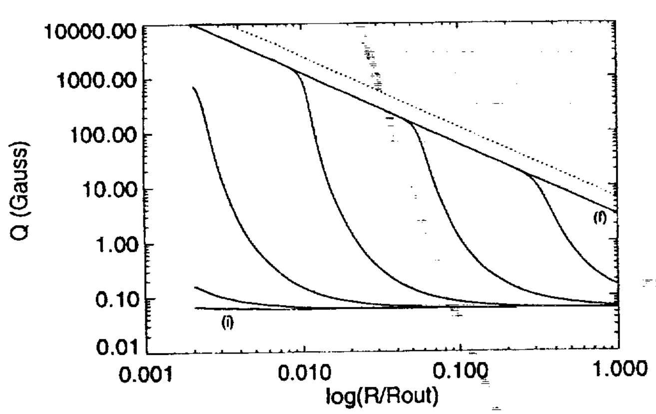

Fig. 1. Radial distribution of magnetic field Q is plotted against dimensionless radius r/r_{out} at various times for the case of an accretion disk around a compact star. The plots (i–f), in order of increasing time, correspond to $t = 10, 10^2, 10^3, 10^4, 10^5, 10^6$, and 10^7 s respectively. The dotted line shows the radial distribution of B_{eq}. After about $t = 10^7$ s the magnetic field equilibrates everywhere in a disk at about half the equipartition value.

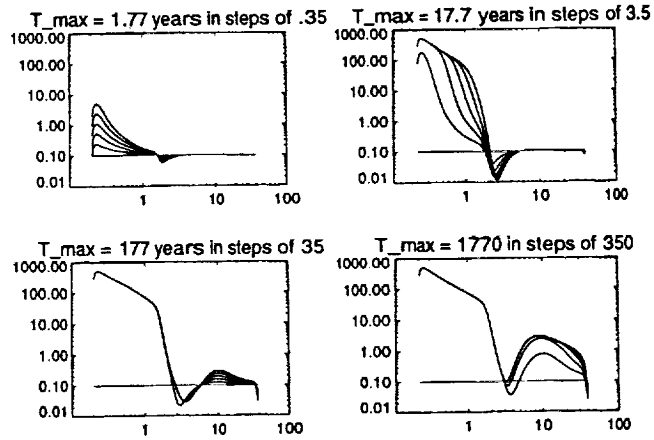

Fig. 2. Time evolution of the magnetic field in a protoplanetary disk from the initial condition Q = 0.1 at t = 0 represented by the horizontal solid line. Magnetic field Q is measured in units of $B_0 = B_{eq}$ (40 AU). Radial distance from the central star is measured in AU.

Such a field could have a substantial effect on the structure and dynamical evolution of thin disks. From an observational point of view, the magnetic field is concentrated close to the inner disk's radius, so it could be difficult to distinguish it from a stellar magnetic field, provided that a central star has a strong field.

References: [1] Stepinski T. F. and Levy E. H. (1991) *Astrophys. J., 379,* 343–355. [2] Frank J. et al. (1985) *Accretion Power in Astrophysics,* Cambridge Univ., Cambridge. [3] Ruden S. P. and Pollack J. B. (1991) *Astrophys. J., 375,* 740–760. [4] Stepinski T. F. (1991) *Icarus, 97,* 130–141.

S23-90 ABS. N94-31139

NONTHERMAL ACCRETION DISK MODELS AROUND NEUTRON STARS.

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We consider the structure and emission spectra of nonthermal accretion disks around both strongly and weakly magnetized neutron stars. Such disks may be dissipating their gravitational binding energy and transferring their angular momentum via semicontinuous magnetic reconnections. We consider specifically the structure of the disk-stellar magnetospheric boundary where magnetic pressure balances the disk pressure. We consider energy dissipation via reconnection of the stellar field and small-scale disk turbulent fields of opposite polarity. Constraints on the disk emission spectrum are discussed.

S24-90 ABS. N94-31140

GRAVITATIONAL INSTABILITIES IN PROTOSTELLAR DISKS.

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The nonaxisymmetric stability of self-gravitating, geometrically thick accretion disks has been studied for protostellar systems