This equation only gives us the local response of the disk to these perturbations, and we see that the α r-dependence plays no role, the major role being locally played by the parameter dependence. When we look for the global response of the disk, this equation no longer applies, being substituted by the correct and more complicated set of coupled differential equations, which solution is highly dependent on the α radial dependence.

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CONVECTIVE SOLAR NEBULA. C. Meirelles Filho and M. Reyes-Ruiz, Space Physics and Astronomy Department, Rice University, Houston TX 77251, USA.

Analyzing turbulent flows with rotation, Dubrulle and Valdettaro [1] have concluded that some new effects come into play and may modify the standard picture we have about turbulence. In that respect the value of the Rossby number is of crucial importance since it will determine the transition between regimes where rotation is or is not important. With rotation there will be a tendency to constrain the motion to the plane perpendicular to the rotation axis and as a consequence the horizontal scale will increase as compared to the longitudinal one, which means that the turnover time in this direction will increase. The net effect is that the energy cascade down process is hindered by rotation. As a matter of fact, when rotation is present one observes two cascades: An enstrophy (vorticity) cascade from large scales to small scales and an inverse energy cascade from small scales to large scales. Since the first process is not efficient on transporting energy to the dissipation range, what we see is energy storage in the large structures at the expense of the small structures. This kind of behavior has been confirmed experimentally by Jacquin et al. [2], who observed that, with rotation, $L_{hor} \approx R_o^{-\gamma} L_z$, where γ is a parameter that depends on the Reynolds number and measures the influence of rotation on turbulence and R_o is the Rossby number. For a very large γ we obtain, in the inertial range, a spectrum of k^{-3} instead of the usual Kolmogorov's $k^{-5/3}$ spectrum. In reality, when rotation is dominant, energy gets stored in inertial waves that propagate it essentially in the longitudinal direction. In that case, we can no longer assign just one viscosity to the fluid and, what is most important, the concept of viscosity loses its meaning since we no longer have local transport of energy. According to Dubrulle [1], $R_o = 1$ is the borderline between these two scenarios: For $R_o > 1$ turbulence is not affected by rotation, for $R_o < 1$ it will be greatly affected. It is worth mentioning that compressibility effects will also affect turbulence through the generation of waves, shocks, etc. These aspects have been underestimated by Cabot et al. [3] in their application of the theory of large-structure turbulence developed by Canuto and Goldman [4] for the turbulence generated by convective instability, in the sense that no discussion about the behavior of the characteristic scale lengths in the problem under the influence of rotation is made nor the conditions under which there will be local energy dissipation and an effective viscosity can be assigned to the flow. Also, not apparent in their results are effects such as inverse energy cascade with consequent diminishing of the angular momentum transport efficiency or even how the spectrum in the inertial zone, i.e., Kolmogorov's spectrum, is affected by rotation. In a previous paper [5], employing results from [1], we have shown that even for Rossby number >1 turbulence is affected by rotation, but it succeeds in forming smaller structures, as compared to the case without rotation, in such a way as to overcome rotational effects. As far as the efficiency of angular momentum transport is concerned, the value of the viscosity parameter is highly affected, even if the Rossby number is much greater than 1.

Such results, however, were derived considering a hot disk, in which opacity is mainly given by electron scattering. In the present work we have applied the formulation developed in the previous work for the description of the viscous-stage solar nebula. Following Wood and Morfill [6] we have used two piecewise continuous powerlaws that depend only on the temperature, corresponding to regions in which opacity is provided either by water ice grains or silicate and Fe grains. It should be remarked, however, that by taking into account the z-structure of the disk, there will be, no matter the radius, a region close to the surface of the disk, where the lower-temperature opacity law applies. As we go further out, this region approaches the midplane of the disk. In the outer regions, where the temperature is below the ice condensation point, only the lower-temperature law is applicable. The height of the point separating these regions will be crucial in the determination of anisotropy factor and the viscosity parameter as well as in the possible existence of critical parameters for the flow. Although our results are preliminary compared to other results in the literature, the efficiency for angular momentum transport we have obtained is higher. These high values of α may imply that within this formulation the viscous evolutionary stage of the nebula is shorter. Our formulation also implies a minimum accretion rate to ignite convective instabilities. Since the mass of the disk is related to the accretion rate the main implication of this is related to the age of the nebula.

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ROTATIONAL EFFECTS IN TURBULENCE DRIVEN BY CONVECTION. C. Meirelles Filho, M. Reyes-Ruiz, and C. Luo, Space Physics and Astronomy Department, Rice University, Houston TX 77251, USA.

We have treated turbulence with rotation in a thin Keplerian disk. Highlighting implicit assumptions already existent in the α model together with a geometrical but physically reasonable deduction of the degrees of freedom of the largest eddies, which is of paramount importance in our formulation, we were able to obtain relations satisfied by parameters of the turbulence, such as turnover time and α. The effects of rotation in the turbulence we have taken implicitly through an anisotropy factor (x), which is simply related to the Rossby number. Convection is the process assumed to generate turbulence, and we have used Canuto and Goldman's [1] treatment of convective instability, whose characteristic growth time we have assumed equal to the turnover time. We have also used their procedure to obtain the turbulent viscosity. When solving for the convective disk equations assuming electron scattering as the source for opacity, by matching Calluto and Goldman's (1984) prescription for the viscosity with the viscosity we have obtained, we were able to obtain an equation for the anisotropy factor, which is coupled to the solution for the growth rate. By solving for the growth rate in the limit of diverging Rayleigh numbers, the equation for the anisotropy factor is simplified and its structure is such that for m (the size of the convective region in units of the height scale) less than a minimum value there will be no steady solution for the turbulence. For m equal to the minimum value there will be only one solution and for m greater than this minimum value there will be two branches of solutions: the lower branch with anisotropy factor <0.5 and the upper branch with anisotropy factor >0.5. We have studied the nature of the turbulence in these branches using Dubrulle and Valdettaro's [2] approach for turbulence with rotation and have reached the conclusion that for $x < 0.5$, i.e., lower branch, there is an increase of the horizontal scale as compared to the longitudinal scale. In that branch the effects of rotation are such that there will be generation of inertial waves that will transport energy; as the dissipation is nonlocal the concept of effective viscosity loses its meaning. In the upper branch, i.e., $x > 0.5$, the horizontal scale will be smaller than the longitudinal scale and the turnover time is smaller than the Keplerian time: Turbulence manages to overcome the effects of rotation and the generation of waves is negligible. Dissipation of energy is local and we can assign the fluid an effective viscosity. It should be remarked that the structures formed with rotation are much smaller than those that would be formed in the absence of rotation. However, turbulence succeeds in overcoming the effects of rotation only in the upper branch. Using Dubrulle and Valdettaro [2] it is highly suggestive that, in the inertial zone, the spectrum will be $k^{-2.07}$, γ being equal to ≈1.3. We have obtained these solutions for both gas-pressure-dominated and radiation-pressure-dominated cases, the solutions being qualitatively similar: decrease of the size of the largest structures as compared to the largest structures formed for turbulence without rotation. The solution in the gas-pressure-dominated case does not depend on the mass of the compact object, nor on the accretion rate, nor on the radial distance. In the radiation-pressure-dominated case the solution will depend on these parameters. The higher the luminosity, the less split the turbulence will be, with higher values for the turbulent mach number and the viscosity parameter, which means higher efficiency for angular momentum transport. Although the rotation rate decreases as we go farther away from the inner radius, the efficiency of angular momentum transport decreases. This is probably due to the assumption of radiation pressure dominance as well as to the kind of opacity law we have used. We should remark that according to Dubrulle and Valdettaro [2] one should expect only one solution with the pattern of turbulence highly dependent on the Rossby number. What we have shown here is that, by a self-consistent calculation of the Rossby number or anisotropy factor, the solution for turbulence generated by convection in a rotation medium is not unique. Both these solutions are affected by rotation.

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A CONSTRAINT ON THE PAIR-DENSITY RATIO (Z_+) IN AN ELECTRON-POSITRON PAIR WIND. M. D. Moscoso and J. C. Wheeler, Department of Astronomy, University of Texas at Austin, Austin TX 78712, USA.

We derive a constraint on the pair density ratio, $z_+ = n_+/n_p$, in an electron-positron pair wind flowing away from the central region of an accretion disk around a compact object under the assumption of a coupling between electrons, positrons, and protons. The minimum rate at which positrons are injected into the annihilation volume is given by the observed annihilation flux per unit volume. This rate is then used to determine a minimum mass loss rate per unit area, $\dot{M}$, for a given pair density ratio at the base of the streamline. The requirement that $\dot{M} < \dot{M}_{Edd}$ (the mean Eddington mass loss rate per unit area) then places a lower limit on the pair density ratio, $z_{+,min}$.

A positron annihilation line was observed in Nova Muscae 1991 by GRANAT/SIGMA. The narrow width and redshift of the line suggest that the pair production and annihilation regions are physically distinct. We hypothesize that an electron-positron pair wind transports the pairs from the production to the annihilation region and calculate $z_{+,min}$. We then determine constraints on the physical parameters on the pair production region by comparing $z_{+,min}$ with previous studies of two-temperature and one-temperature accretion disks with electron-positron pairs.

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CIRCUMSTELLAR MATERIAL AROUND YOUNG STARS IN ORION. C. R. O'Dell, Department of Space Physics and Astronomy, Rice University, P.O. Box 1892, Houston TX 77251, USA.

The star cluster associated with the Orion nebula is one of the richest known [1]. Lying at the nearside of the Orion Molecular cloud and at a distance of about 500 pc from us, it contains many pre-main-sequence stars with ages of about 300,000 yr [2]. The nebula itself is a blister type, representing a wall of material ionized by the hottest star in the Trapezium group (member C).

Although this is not the closest star formation region, it is probably the easiest place to detect circumstellar, possibly protoplanetary, material around these solar mass stars. This is because the same process of photoionization that creates the nebula also photoionizes these circumstellar clouds, thus rendering them easily visible. Moreover, their dust component is made visible by extinction of light from the background nebula.

Young stars with circumstellar material were found in Orion on the second set of HST images and were called proplyds, indicating their special nature as circumstellar clouds caused to be luminous by being in or near a gaseous nebula [3]. The brightest objects in the field had previously been seen in the optical [4] and radio [5], and although their true nature had been hypothesized [6,7] it was the HST images that made it clear what they are. The forms vary from cometlike when near the Trapezium to elliptical when further away, with the largest being 1000 AU and the bright portions of the smallest, which are found closest to the Trapezium, being about