We argue that the proper way to treat thin–thick accretion-disk transitions should take into account the 2-D nature of the problem. We illustrate the physical inconsistency of the 1-D vertically integrated approach by discussing a particular example of the convective transport of energy.

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Traditionally, accretion disks are modeled using a dimensional splitting method, in which the vertical structure is solved locally at each radius. Although this procedure is evidently correct for thin disks, it may be questionable for thick disks that have a non-negligible geometric thickness, and for thin or thick disks experiencing a sharp transition (stationary or non-stationary) from one state to another.

Advection-dominated accretion flows (ADAFs) are now widely regarded as being the source of Comptonized X-ray radiation observed from many X-ray binary sources. It is believed that in such a source, the ADAF is located in the inner part of an accretion disk around a compact object, while the outer part is most likely a standard Shakura–Sunyaev disk (SSD). A transition from the SSD to an ADAF may occur at hundreds or thousands of gravitational radii from the central compact body. The physical cause of the transition remains elusive. 1-D ADAF models based on vertical integration are remarkably successful in explaining the observed spectra (see e.g. Narayan et al. 1996; Narayan et al. 1997a). It is easy to overlook, however, that this by itself does not prove that these models are able to correctly describe the SSD–ADAF transitions.

Indeed, in this Note we argue that 1-D methods that have been used to study ADAFs, cannot describe transitions between ADAFs and SSDs. The problem here is not only with accuracy, but also with the very physical consistency of these methods. For this reason, several recent ideas and results concerning the SSD–ADAF transitions cannot be trusted.

We illustrate the physical inconsistency of the vertical integration approach, which is the most often used 1-D method, by discussing a particular example of the convective transport of energy. In principle, one may argue (as e.g. Honma 1996a) that a convective energy flux that originates in the inner part of the ADAF could be deposited in inner edge of the outer SSD, causing its ‘evaporation’ thereby sustaining the SSD–ADAF transition. In reality, most of the convective flux goes in the vertical direction and never reaches the SSD. By vertical integration one artificially forces all of this flux to be deposited in the SSD.

The physical inconsistency of the 1-D methods should not be confused with the fact that the global models constructed by such methods could be formally self-consistent. Indeed, the formal self-consistency of the 1-D ADAF models is connected to the fact that the vertically integrated method always produces a smooth radial dependence of the scale height in global solutions (Narayan et al. 1997b; Chen et al. 1997). However, it is most likely that SSD–ADAF transitions are far from being smooth, as has been demonstrated in 2-D hydrodynamics simulations by Abramowicz, Igumenshchev, and Lasota (1998). In this paper, we extend the argument by pointing out that the two-dimensional nature of the transition is also important for the heat flux. We consider a particular case of a convective heat flux, because it is known to be important for ADAFs (Narayan, Yi 1994; Igumenshchev et al. 1996).