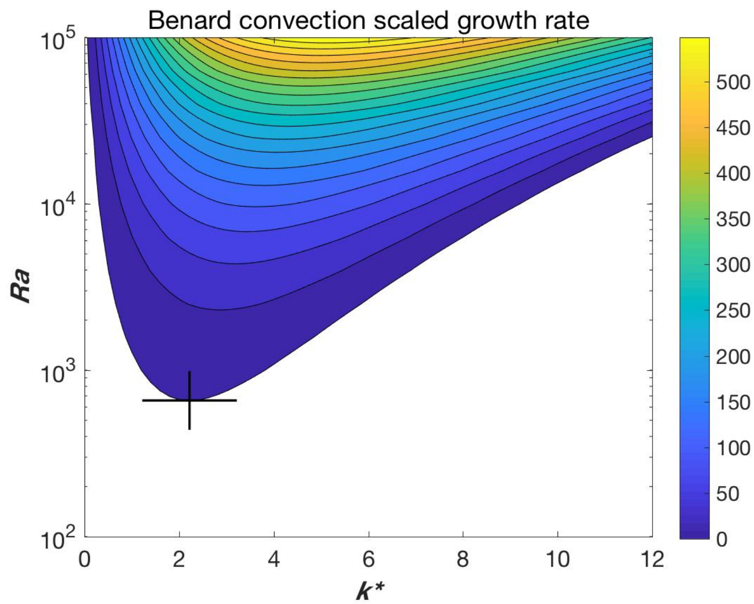

Figure 1: Growth rate versus wavenumber and Rayleigh number for the Benard problem. The cross indicates the analytical stability limit.

19: Sheared convection

(a) The stratified shear flow routine correctly reproduces the analytical stability boundary for the Benard problem (figure 1).

(b) With no shear, the growth rate is independent of the obliquity angle (figure 2). When shear is added, the symmetry is broken. When $\ell\star = 0$, the effect of shear is to decrease the growth rate. The growth rate is greatest when $\varphi = \pm 90^o$, i.e. when the convection rolls are aligned in the x direction. This effect is partly responsible for the secondary instability of KH billows shown by the arrow in figure 12.1b. The billow has overturned the stratified fluid so as to produce convective instability aligned with the sheared background flow.

According to Squire's theorem (section 4.3.2), instability is affected only by the component of the shear flow parallel to the wave vector. Knowing only that the effect of shear is to reduce the growth rate, we could have predicted that the reduction is least when the wave vector is perpendicular to the shear, just as shown in figure 2.

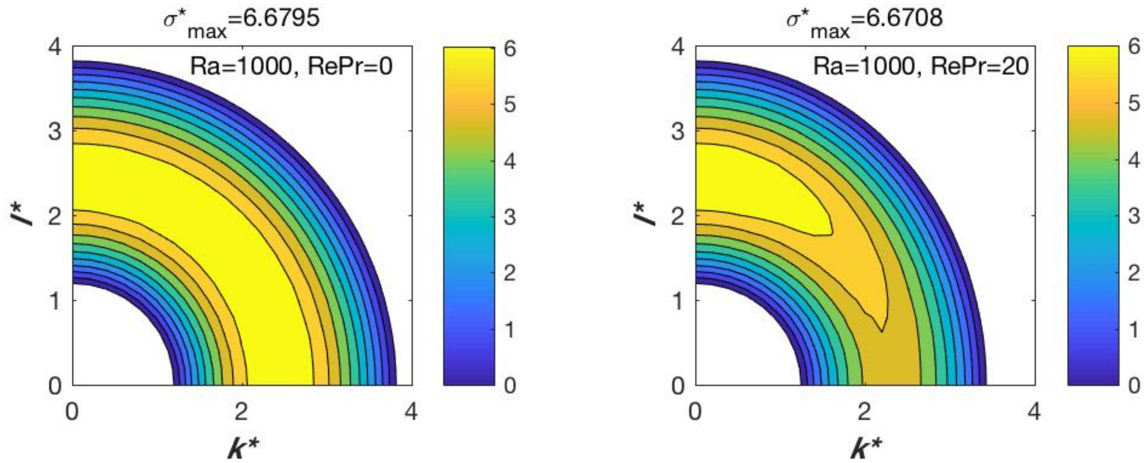

Figure 2: Growth rate versus wavenumber for the Benard problem: unsheared (left) and sheared (right).