According to Ostriker [16] and Mestel [13] a cylindrical equilibrium configuration is possible only if the mass per unit length along the cylinder has the value:

$$M/L = 2\mathscr{R}\,T/G, \tag{5.8}$$

where $\mathscr{R}$ is the perfect gas constant. With the assumed initial conditions for $T = 10$K, the gas pressure and the gravity should nearly balance. Figure 4b shows the density distribution resulting at a typical time in the collapse ($t = 2.3 \times 10^{12}$ s) when a temperature of 7.5K is assumed. In this case the horizontal pressure gradient is insufficient to prevent the horizontal collapse. On the contrary, when a temperature of 13K is assumed (Fig. 4d), the pressure gradient leads to a horizontal expansion and, for the critical temperature $T = 10$K, an equilibrium is observed (Fig. 4c). But at greater time, the simulation leads in all cases to a vertical collapse.

The second simulation consists in the collapse of a spherical rotating cloud with uniform initial density $\rho = 4.7 \times 10^{-19}$ g cm^{-3} and 6000 particles (Fig. 5a). The same initial conditions as Larson [10] and Black and Bodenheimer [3] have been taken, i.e., a rotation velocity of $0.9\omega_c$, where ω_c is the critical rotation velocity for the collapse given by

$$\omega_c^2 = 5/R^2(0.42GM/R - c_s^2), \tag{5.9}$$

where c_s is the sound speed. Initially the collapse is mainly in the Z-direction, as the cloud is centrifugally supported in the $X-Y$ plane (Figs. 5b–c). Then a strong shock forms in the central region and the cloud collapses in the $X-Y$ plane (Figs. 5d–g). At the end, the formation of a ring is observed (Fig. 5g) at a position comparable to that found by Black and Bodenheimer [3] but the ring is gravitationally unstable and collapses in the end. These results can be compared with Wood's 3D SPH simulations [19] with only 500 particles and therefore low resolution. He found that, finally, a non-axisymmetric mode becomes unstable, which justifies the 3D simulations.

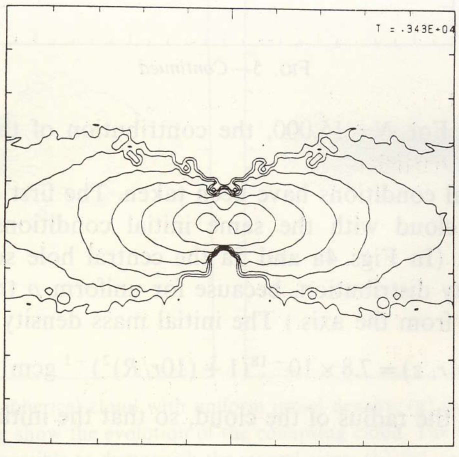

FIG. 6. Density levels resulting from the collapse of the rotating cloud.