and Tomisaka, Ikeuchi, & Nakamura (1988) used the same technique to find the structure of axisymmetric magnetized clouds that can be reached from *nonequilibrium spherical* configurations. By contrast, we start from a cylindrical configuration in magnetohydrostatic equilibrium as those used to study the gravitational collapse and fragmentation of filamentary clouds (e.g., Nakamura, Hanawa, & Nakano 1995). In these simulations, however, the gravitational instabilities play a dominant role and not the Parker instability itself. In order to isolate the outcomes of the Parker instability, we will not consider self-gravity of the gas. In addition, we will also ignore the destabilizing influence of the interchange mode and the magnetic field curvature in the equilibrium states (Asséo et al. 1978, 1980; Lachièze-Rey et al. 1980), which could lead to the development of substructure. The study of these instabilities requires a full magnetohydrodynamical model and they will not be discussed further here.

Our paper is organized as follows. In § 2, we describe the initial equilibrium configurations. The elliptic differential equations that give the equilibrium states under flux-freezing conditions are provided in § 3. In § 4 we compare the resulting features of the final states arising from the Parker instability in Cartesian and axisymmetric models. A summary of the results is presented in § 5.

## 2. INITIAL STATES

We consider first the initial state in the Cartesian model, that is, a planar layer that is supported against the vertical gravity field by the gas pressure $P$ and a horizontal magnetic field. We will use a Cartesian coordinate system $(x, y)$, where $x$ is the horizontal coordinate and $y$ is the distance to the midplane of the layer, so that $\vec{B}_0 = (B_{0,x}(y), 0)$ in the initial state. Throughout the paper, the subscript 0 signifies the initial state. Magnetohydrostatic equilibrium is satisfied if

$$\vec{\nabla}\left(P_0 + \frac{B_{0,x}^2}{8\pi}\right) = -\rho\vec{\nabla}\psi, \tag{1}$$

where $\psi = \psi(y)$ is the gravitational potential. If the gas is isothermal with thermal sound speed $c_s$ and the ratio of the magnetic to gas pressures, $\alpha \equiv B_0^2/8\pi P_0$, is constant, the equilibrium equation reads

$$(1+\alpha)c_s^2\vec{\nabla}\ln\rho_0 = -\vec{\nabla}\psi, \tag{2}$$

which has the solution

$$\rho_0(y) = \rho_0(0)\exp\left(-\frac{\psi}{(1+\alpha)c_s^2}\right), \tag{3}$$

with $\psi(0) = 0$. If the gravitational field $\vec{g} = -\vec{\nabla}\psi$ is taken to be vertical and constant (but it reverses its direction across the midplane), we have $\psi = g|y|$, with $g$ = constant $> 0$. In this particular case, the mass density decays exponentially with a typical scale $H$ of $(1+\alpha)c_s^2/g$, whereas the magnetic field strength decays with a characteristic scale $2H$.

If, instead of a planar atmosphere, we assume that the gas extends to infinity along a cylinder whose axis coincides with the $z$-axis, and is threaded by an axial magnetic field $B_z$, the density profile at equilibrium is:

$$\rho_0(R) = \rho_0(0)\exp\left(-\frac{\psi}{(1+\alpha)c_s^2}\right), \tag{4}$$

where $R$ is the radial distance in cylindrical coordinates and $\psi(R)$ is the gravitational potential, with $\psi(0) = 0$. In fact, we assume that the gravitational acceleration has only a radial component. If the radial gravitational force is taken to be constant, it holds that $\psi = gR$. Therefore, the radial scalelength for the density is$H = (1+\alpha)c_s^2/g$, as in Cartesian geometry.

We see that if the gravitational potential $\psi(y)$ in the infinite planar layer is identical to the gravitational potential $\psi(R)$ in the cylindrical model, the profiles of density, magnetic field and gas pressure along $y$ and $R$ will be identical in both models. However, these systems are no longer equivalent when the Parker instability arises. In the Cartesian model, magnetic field lines are allowed to inflate only in the vertical direction, whereas the expansion of field lines as well as the contraction of matter occur radially in the axisymmetric model (see Figure 1). The question that arises is how the distributions of density, pressure and field lines in an azimuthal section [i.e. in the $(z, R)$-plane] will look like as compared to those found in a vertical section [i.e. in the $(x, y)$-plane] in the well-studied Cartesian model.

When studying the Parker instability at the solar neighborhood, it is common to use a local Cartesian frame where the azimuthal direction is identified with the horizontal coordinate $x$ and the vertical direction in the Galaxy with $y$. In the two-dimensional approximation, the third (radial) direction is ignored. As a cautionary comment, our coordinate $R$ used throughout the paper should not be confused with the radial direction in the Galaxy.

## 3. THE EQUILIBRIUM EQUATIONS

If a disturbance of sufficiently long wavelength is applied along the initial magnetic field to the initial equilibrium states described in the previous section,