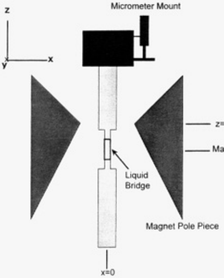

FIG. 1. Schematic view of the experimental setup. The fluid injection system, involving a hypodermic needle that injects material from the side, is not shown.

ment of its position along the z-axis relative to the lower tip, and the tip of the lower rod was placed at approximately 0.4 cm below $z=-0.8$ cm. ($z=0$ corresponds to the point where the pole pieces reach their closest approach, and $z=-0.8$ cm is the position of maximum $H_x\partial_z H_x$.) The lower tip was placed at this position so that the center of the liquid column would be at the approximate maximum in $H_x\partial_z H_x$. A boroscope attached to a CCD camera was positioned along the y-axis to view the liquid bridge, and the images were recorded with a videocassette recorder. The magnetic field was

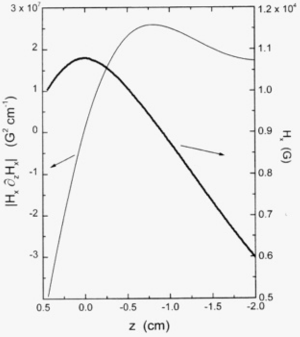

FIG. 2. Magnetic field H_x(right axis) and $H_x\partial_z H_x$ (left axis) vs vertical position z at $H=H_{comp}$. $z=0$ corresponds to the position of closest approach of the pole pieces (see Fig. 1). The quantity $H_x\partial_z H_x$ is maximum at $z=-0.8$ cm.

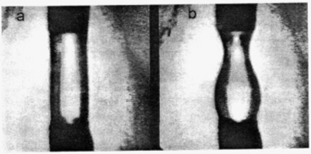

FIG. 3. Photograph of $d=0.32$ cm liquid bridge with $R=2.39$. (a) Stable bridge with $H_x\partial_z H_x$ adjusted to approximately $(H_x\partial_z H_x)_{comp}$, so that B is close to zero. (b) Stable bridge with $H_x\partial_z H_x$ reduced, so that $B=0.09$ [cf. Eq. (1)]. Note that when $H_x\partial_z H_x$ is further reduced, so that $B\sim 0.093$, the bridge collapses.

adjusted so that ∇H^2 approximately corresponded to ∇H^2_{comp}, and liquid was injected into the gap (typically starting at 0.1 cm) between the tips using a 25 gauge butterfly hypodermic needle and syringe. The upper tip was then translated upward using the micrometer, thereby creating a liquid cylinder between the two tips. As the upper tip was further translated, a waist formed in the column and more liquid had to be added to maintain a uniform cylinder. During this procedure the magnetic field also had to be fine-tuned to prevent sagging. This procedure was continued until a uniform cylinder of a desired length L (and thus a given slenderness ratio $R=L/d$) was achieved. For the longest cylinders ($0.8<L<1.0$ cm), the shape of the cylinder was found to be extremely sensitive to magnetic field: We found that if $H_x\partial_z H_x$ were to deviate from 2.57×10^7 G^2 cm^{-1} [defined as $(H_x\partial_z H_x)_{comp}$] by more than 1%, a noticeable bulge in the cylinder would appear near the top (for too large a field) or the bottom (for too small a field). Thus knowing the density ρ and $(H_x\partial_z H_x)_{comp}$, we were able to extract the volumetric magnetic susceptibility (per cm^3) $\chi=\rho g/(H_x\partial_z H_x)_{comp}$ $=(5.54\pm 0.05)\times 10^{-5}$. We note that during the course of the experiment the relative humidity was kept near 100% to minimize evaporation of the water. Had we not done so, water evaporation would have increased the concentration of the paramagnetic salt in the column, and therefore changed the susceptibility.

RESULTS

Let us now turn to the stability of the column as a function of the Bond number. For our experiment the Bond number B must be redefined to include the effects of the magnetic field, viz.,

$$B\equiv\frac{(\rho g-\chi H_x\partial_z H_x)d^2}{4\sigma}. \tag{1}$$

As described above, columns of a given slenderness ratio R were created and stabilized in a magnetic field gradient, such that $(H_x\partial_z H_x)_{comp}=2.57\times 10^7$ G^2 cm^{-1}; this corresponds to $B=0$. Then B was varied either positively or negatively by decreasing or increasing the magnetic field from its value H_{comp}. For a given R there was some maximum and minimum field, corresponding to a negative and positive Bond