density ρ_{D2O} is approximately 11.1% larger than that of H_2O, could be titrated into the bath, thereby facilitating a variation of $\Delta\rho$ and thus of Bond number. After the ends of the rods had been wetted with liquid crystal, the tank was filled with H_2O. The length of the column was controlled by the micrometer, which allowed us to translate the top rod upward. As we did so, more liquid crystal was injected into the gap in order to maintain a right circular cylindrical bridge, i.e. a volume $V=\pi d^2 L/4$. Upon reaching a desired slenderness ratio R (less than π), the entire assembly was heated to 36.5°C, above the nematic–smectic A transition temperature $T_{NA}=33.5$°C. As the density of the nematic phase $\rho_N=0.985\ \mathrm{g\,cm^{-3}}$ [18] is less than the water bath ($\Delta\rho \sim 0.009\ \mathrm{g\,cm^{-3}}$), the bridge began to deform (figure 2), but did not collapse. D_2O of density $\rho_{D2O}=1.102$ at $T=36.5$°C was then titrated into the tank in order to further increase $\Delta\rho$. For sufficiently large $\Delta\rho$ the bridge finally collapsed. Note that during this process the volume of the bridge remained constant, even as it became deformed by the addition of D_2O to the bath.

Coriell, *et al.* calculated the maximum value of the initial slenderness ratio R for an isotropic liquid that corresponds to the limit of stability for a given Bond number B [4]. Throughout the region $B \leqslant 0.1$, an excellent approximation to their result is the empirical form

$$R=a+b_1\exp\left(\frac{-B}{c_1}\right)+b_2\exp\left(\frac{-B}{c_2}\right) \qquad (2)$$

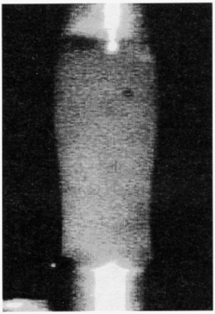

Figure 2. Deformed, but stable, nematic bridge. The density of the bath is higher than the density of the nematic, resulting in an upward bulge of the liquid crystal.

where the five dimensionless parameters are: $a=2.21$, $b_1=0.81$, $b_2=0.12$, $c_1=0.071$, and $c_2=0.0038$. Additionally, Meseguer found an analytic asymptotic form, viz. $R=\pi[1-3/2(3/2\,B^2)^{1/3}]$ [19], although this is valid only in the limit of $B\to 0$ and breaks down in the larger Bond number region of our experiment.

Assuming that the nematic phase behaves as an ordinary Newtonian fluid, we substituted equation (1) into equation (2). This gives R at the stability limit in terms of $\Delta\rho$ (which is the experimentally-controlled variable) and σ at the nematic–water interface (which is the unknown parameter). The stability of the nematic bridge was examined for a number of different slenderness ratios, all of which gave consistent results. From the data we extracted a surface tension $\sigma=(16\pm1)\ \mathrm{erg\,cm^{-2}}$. Figure 3 shows R versus the density mismatch $\Delta\rho$ at which the bridge collapses. The curve, cf. equation (2), is a best fit to the data with the fitting parameter $\sigma=16\ \mathrm{erg\,cm^{-2}}$. The behaviour of the nematic bridge is clearly similar to that of an isotropic Newtonian liquid bridge [4]. This is not really surprising, as the only significant differences between the two are the orientational order of the nematic phase and the associated elastic energy associated with director distortions. In order to estimate the role of orientational elasticity, we imagine the elastic energy associated with a pinching of the bridge; this would approximately correspond to the energy of a hemispherical cap of radius $r=d/2$. Neglecting the energy associated with disclinations, we may estimate the elastic energy of a nematic cap as $F_{\mathrm{elastic}} \sim 1/2\,Kr^{-2}\times 2/3\,\pi r^3$, where K is a typical elastic constant of order 10^{-6} dyn [20]. Taking r as the radius of the end of the bridge ($r=0.16$ cm), we find $F_{\mathrm{elastic}} \sim 2\times 10^{-7}$ ergs. On the other hand, the energy associated with the surface tension for the hemispherical cap is $F_{\mathrm{surface}} \sim 2\pi r^2\sigma$, or approximately 3 ergs. Owing to the large radius of curvature, the surface term is clearly orders of magnitude larger than the elastic term. In consequence we would expect the elasticity of the nematic phase to play only a negligible role in the behaviour of the bridge, and the nematic bridge would respond in a manner similar to that of an isotropic liquid bridge.

2.2. *The smectic A phase*

Let us now turn to bridges in the smectic A phase. The smectic A phase is known to exhibit significant 'shear thinning', wherein the viscosity decreases markedly with increasing strain rate. The viscosity versus shear strain rate was measured for 8CB more than a dozen years ago, and was found to exhibit extreme thinning behaviour [21]. In addition to the non-Newtonian shear thinning, bulk smectic A samples tend to exhibit viscoelastic behaviour with a shear yield stress Y. For shear