Erratum: Theory of water and charged liquid bridges [Phys. Rev. E 86, 026302 (2012)]

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In this paper, an incorrect statement appears, which is not necessary, although it does not alter the further treatment. On p. 3, after Eq. (13), the erroneous statement reads: "The radius of the bridge at the beaker is nearly independent of the applied electric field and only depends on the surface tension and gravitational force." This is an oversimplification, which can be improved by a simple energy consideration in the same spirit as used in the paper leading to a field-dependent radius. Let us assume that the form of the bridge at the top of the beaker $z = 0$ can be approximated by a cylinder with a radius R within an infinitesimal small length δL in the y direction. The gravitational energy is easily calculated as $E_g = \rho g \int z\, dV = \rho g \pi R^3 \delta L$, the surface energy $E_s = \sigma \int dA = 2\pi\sigma R\, \delta L$, and the field energy due to dielectric pressure $E_d = \frac{1}{2}\rho g b \int dV = \frac{1}{2}\rho g b \pi R^2 \delta L$ with the creeping height $b(E) = \epsilon_0(\epsilon - 1)E^2/\rho g$ [Eq. (2) in the paper]. The bulk charge energy $E_c = \rho_c \int y\, dV = \rho_c \pi R^2 \delta L^2/4$ would go with δL^2 and would vanish relative to the above contributions. Extremizing the expression $E_s + E_d - E_g$ with respect to R leads to the radius,

$$R = \frac{1}{6}\left(b + \sqrt{b^2 + 12a^2}\right),$$

with the capillary height $a = \sqrt{2\sigma_s/\rho g}$ [Eq. (1) in the paper], which shows that the radius of the bridge at the beaker increases with the field parameter $b \sim E^2$. Since we have neglected the flux energy, this expression overestimates the field dependence. In rewriting the Bernoulli equation (29) into (30), the second part a on the right side of (30) has to be replaced, consequently, by

$$a \to \frac{3a^2}{b + \sqrt{b^2 + 12a^2}},$$

which leads to a slightly higher field dependence of the profile of the bridge than reported in the paper. The field-dependence of R also changes the characteristic velocity [Eq. (4) in the paper] to get an additional factor of $4R^2/a^2$ which approaches the value $4/3$ for small fields.

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