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CORRECTION

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Correction: Optical response of magnetically actuated biocompatible membranes

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Correction for 'Optical response of magnetically actuated biocompatible membranes' by H. Joisten *et al.*, *Nanoscale*, 2019, **11**, 10667–10683, https://doi.org/10.1039/C9NR00585D.

A. Correction of the force expression in eqn (5):

The authors regret that the force F_Z expression (in the original eqn (5) p. 10673), was not fully appropriate to calculate the mechanical force exerted on the particle. The first term of the sum in the original eqn (5), although resulting from an exact mathematical derivation of the product $V_P{\cdot}(M(Z){\cdot}B(Z))$ with respect to Z, should be removed. This term $V_P{\cdot}\mathrm{d}M/\mathrm{d}B_z \times \mathrm{d}B_z/\mathrm{d}Z \times B_z$ in eqn (5) should be interpreted as the work of internal forces on the local magnetization within the particle, and not as a contribution to the external mechanical force exerted by the magnet on the particle. The second term $V_P{\cdot}M(Z) \times \mathrm{d}B(Z)/\mathrm{d}Z$ is the correct expression of the mechanical force exerted on a particle *via* the magnetic field gradient, as detailed by Brown (Ch. 4, §2).[1] The corrected eqn (5), as expressed *e.g.* in ref. 2–4 and in our more recent publication,[5] is :

$$F_Z(Z) = V_P \cdot \left(M(Z) \cdot \frac{\mathrm{d}B_Z}{\mathrm{d}Z}(Z) \right) \tag{5}$$

The curves $F_Z(Z)$ are corrected in the revised Fig. 5, shown below. This $F_Z(Z)$ correction to a correction of the experimental distances Z, as detailed below. The magneto-elastic and optical models and experiments corroboration, the discussion and conclusion of the original article remain unchanged.

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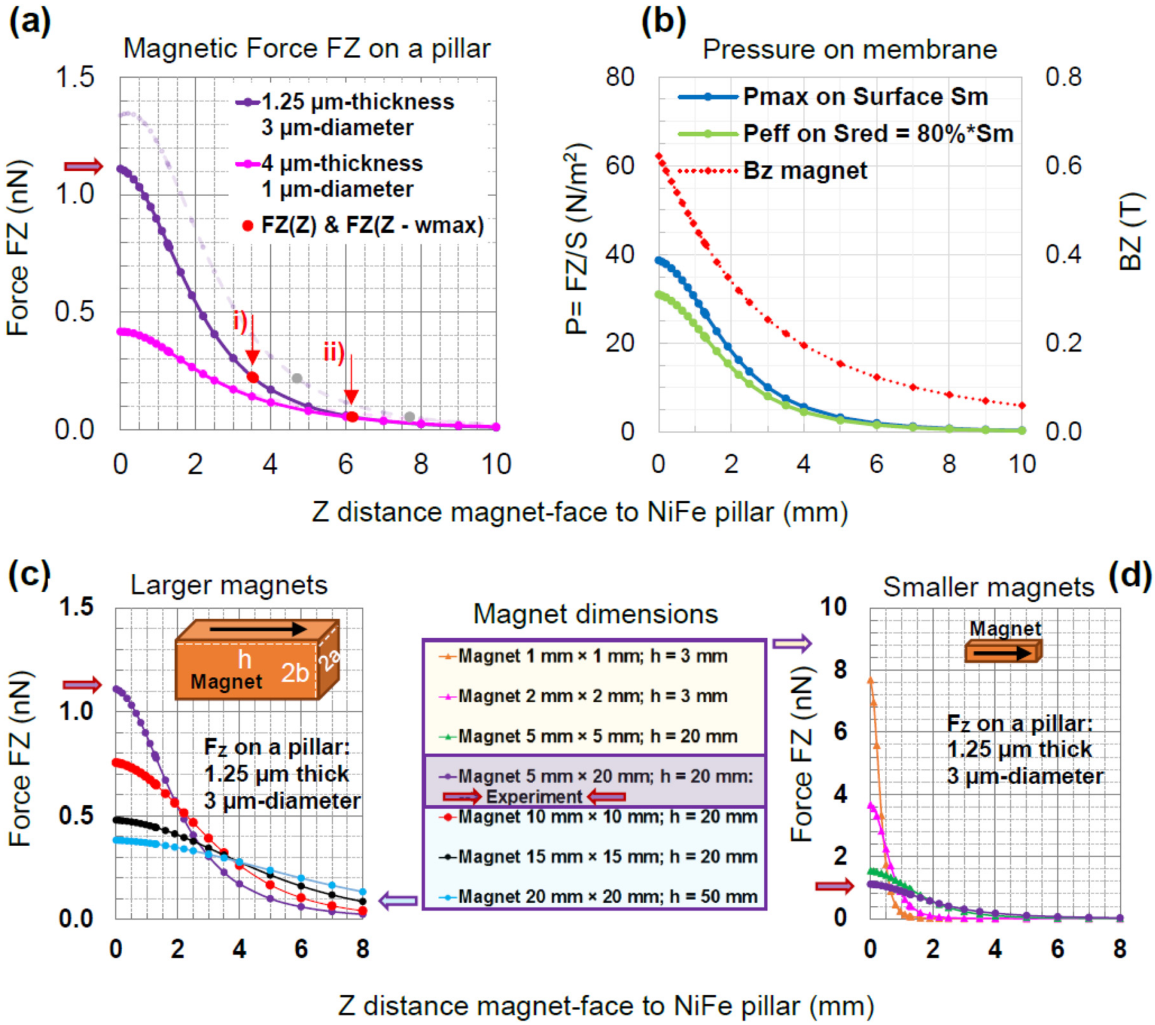

Fig. 5 Modelled magnetic forces F_Z, generated by the magnet on NiFe pillars, and resulting pressure P_Z loading the membrane tested in optics (membrane of surface S_m, diameter 8 mm, $P_Z \sim \sum(F_Z/S_m)$). Experimental NdFeB magnet of section $2a \times 2b$ = 5 mm × 20 mm, height h = 20 mm, $\mu_0 M_{MAG}$ = 1.29 T; NiFe pillars of $\mu_0 M_s$ = 1 T. (a) (1) F_Z on a NiFe pillar of ⌀ 3 µm, thickness 1.25 µm, imaged in Fig. 2(e–g); $\mu_0 H_{SAT} \approx 0.36$ T, saturated for $Z \leq 1.7$ mm. (2) F_Z on a NiFe pillar of ⌀ 1 µm, thickness 4 µm, imaged in Fig. 2(a), $\mu_0 H_{SAT} \approx 0.12$ T, saturated for $Z \leq 6$ mm. In (i) and (ii) respectively coincide 3 close dots: (i) (1) $F_Z(Z = 3.55$ mm$) = 0.222$ nN; (2) $F_Z(Z = 3.55$ mm-38 µm$) = 0.226$ nN yielding F_Z variation of 2% for d$Z = w_{max}$ = 38 µm; (3) similarly for dZ = 50 µm, $F_Z(Z = 3.55$ mm-50 µm$) = 0.228$ nN. (ii) (1) $F_Z(Z = 6.2$ mm$) = 0.0557$ nN; (2) $F_Z(Z = 6.2$ mm-23.8 µm$) = 0.0563$ nN yielding F_Z variation of 1% for d$Z = w_{max}$ = 23.8 µm; (3) similarly for dZ = 50 µm, $F_Z(Z = 6.2$ mm-50 µm$) = 0.0570$ nN. Dashed curve in light grey added: from original Fig. (5). (b) Pressure $P_Z(Z)$ on a membrane shown in Fig. 2(c), NiFe thickness = 1.25 µm; hexagonal array; unit-cell of surface S_{cell} with pillars of radii: 1 × (R = 2 µm) + 3 × (R = 1 µm); $P_Z(Z) = \sum(F_Z)/S_m = [1 \times F_Z(R = 2\ \mu m) + 3 \times F_Z(R = 1\ \mu m)]/S_{cell}$. In blue color: a maximized $P_{Zmax}(Z)$, with $B(X,Y,Z)$ assumed = $B(0,0,Z)$ over the whole surface S_m; in green color: an effective pressure P_{Zeff}, with $B(X,Y,Z)$ assumed = $B(0,0,Z)$ over a reduced surface S_{red}, and B = 0 near membrane edges; $S_{red} \approx 80\% \times S_m$. $P_{Zeff} = 0.80 \times P_{Zmax}$. In red color: $B_Z(Z)$ inducing the pressure. (c and d) Modelled forces F_Z, exerted by magnets of various dimensions on a NiFe pillar of ⌀ 3 µm, thickness 1.25 µm, along OZ axis only; F_Z compared to F_Z from our experimental magnet of section 5 mm × 20 mm, height h = 20 mm. (c) Magnets of larger sections than the membrane of surface S_m, two heights, yielding smaller forces on OZ near Z = 0: appropriate if the magnet is placed relatively "far" from the membrane. (d) Magnets of smaller sections than the membrane surface S_m, two heights, yielding locally larger forces on OZ near Z = 0, appropriate if the magnet is placed close to the membrane (requiring thus more flexibility).

B. Correction of typos found in the original article

(B1). The authors regret that the original eqn (3) and (4) for the field and its gradient, contained the following typos, p. 10673: "π" is missing, and in eqn (3) $\tanh^{-1}$ should be replaced by $\tan^{-1}$.

- The original eqn (3) is corrected as:

$$B_Z(X,0,Z) = [b_Z(X,0,Z) - b_Z(X,0,(Z+h))] \tag{3}$$

where

$$b_Z(X,0,Z) = \left(\frac{\mu_0 M_{MAG}}{4\pi}\right)\cdot 2\cdot\left[\tan^{-1}\left(\frac{(X+a)\cdot b}{Z\cdot\sqrt{(X+a)^2+b^2+Z^2}}\right)-\tan^{-1}\left(\frac{(X-a)\cdot b}{Z\cdot\sqrt{(X-a)^2+b^2+Z^2}}\right)\right]$$

- The original eqn (4) is corrected as:

$$\mathrm{d}B_Z(0,0,Z)/\mathrm{d}Z = \left(\frac{\mu_0 M_{MAG}}{4\pi}\right)\cdot 4\cdot[g(Z+h)-g(Z)] \quad (4)$$

where

$$g(Z) = \left(a\cdot b\cdot\left(a^2+b^2+2\cdot Z^2\right)\right)/\left(\left(a^2+Z^2\right)\cdot\left(b^2+Z^2\right)\cdot\left(\sqrt{a^2+b^2+Z^2}\right)\right)$$

(**B2**). The authors wish to correct the following typographic errors (not present in the calculations):
- In the Fig. 3 legend, p. 10671, "$k = 55$" should be replaced by "$k = 2.85$".
- In the text, p. 10675, left column, "$F_{Zcell} = 1 \times F_Z(R = 4\ \mu m) + 3 \times F_Z(R = 2\ \mu m)$", should be replaced by: "$F_{Zcell} = 1 \times F_Z(R = 2\ \mu m) + 3 \times F_Z(R = 1\ \mu m)$".
- In the Fig. 6 legend, p. 10676, Poisson's ratio "$\nu = 0.49$" should be replaced by: "$\nu = 0.42$".
These typos do not change the results, discussion or conclusion of the original article.

C. Corrected figure and Z distances resulting from the corrected eqn (5):

(**C1**) The original Fig. 5 should be replaced by the corrected version here (where F_Z and the pressure curves are recalculated using the corrected eqn (5) given here).

Information on the corrected Fig. 5:

- In the revised Fig. 5(a), a curve from the original Fig. 5(a) is shown in light grey color (for 3 µm-diameter (1.25 µm thick)), the corrected curve (in purple color) is below the original one (light grey dashes). For 1 µm-diameter (4 µm thick), the corrected curve (pink color) is superimposed on the original one, unchanged because of the magnetic saturation.
- In the revised Fig. 5(b–d), corrected curves only are shown. At very small applied magnetic fields, F_Z calculated by the corrected eqn (5) here is halved compared to its value from the original eqn (5) ($\mathrm{d}M/\mathrm{d}B \to M/B$ if $B \to 0$). For larger magnetic field yielding the saturation of the particle, F_Z calculated by the corrected eqn (5) is unchanged from the original eqn (5) ($\mathrm{d}M/\mathrm{d}B \to 0$).

(**C2**) Correction of the Z distances .

Experiments and models of the elastic membrane deformation and optical diffraction patterns remain unchanged, with the same magnitudes of forces F_Z and pressures at play. With the corrected eqn (5), the magnet-to-membrane distances Z should be re-estimated: given force or pressure are obtained with a magnet closer to the particle or to the membrane than in the original manuscript. In the optical experiments 1 and 2 in the initial manuscript, the magnet-to-membrane distances Z were not precisely measured, but approximately estimated visually in the experimental set-up (~1 to 10 mm), and then adjusted in the models. With the corrected eqn (5), the precise setting of the distance Z should be reassessed, based on the corrected $F_Z(Z)$ and pressure, resulting in:

Experiment 1: corrected $Z = 3.55$ mm (yielding $w_{max} = 23.8$ µm); instead of original $Z = 4.7$ mm.

Experiment 2: corrected $Z = 6.2$ mm (yielding $w_{max} = 38$ µm); instead of original $Z = 7.7$ mm.

These two distances should be corrected in the text and figure legends, at seven locations in the original manuscript. Corrections are made here in the revised Fig. 5 legend.

In the text p. 10676 and p. 10679; in the Fig. 6 legend p. 10676; in the Fig. 9 legend, p. 10680:
"$Z =$ or $Z \sim 4.7$ mm" should be replaced by "$Z =$ or $Z \sim 3.55$ mm"
"$Z =$ or $Z \sim 7.7$ mm" should be replaced by "$Z =$ or $Z \sim 6.2$ mm",
In the text p. 10679; in the Fig. 6 legend, p. 10676; in the Fig. 9 legend, p. 10680:
"$B_Z =$ or $B_Z \sim 0.09$ T" should be replaced by "$B_Z =$ or $B_Z \sim 0.12$ T",
"$B_Z =$ or $B_Z \sim 0.16$ T" should be replaced by "$B_Z =$ or $B_Z \sim 0.22$ T".

Note that these corrections do not change the principles shown in the original manuscript, the discussion, corroborations of models and experiments and conclusion.

The Royal Society of Chemistry apologises for these errors and any consequent inconvenience to authors and readers.

References

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