Errata of Alternative method to calculate the magnetic field of permanent magnets with azimuthal symmetry

V. Sosa[a] and A. Vázquez[b]

[a]*Cinvestav-IPN Unidad Mérida, Departamento de Física Aplicada,*
Apartadi Postal 73 Cordemex, 97310, Mérida, Yuc., México.
e-mail: victor.sosa@cinvestav.mx
[b]*Universidad Autónoma de Yucatán, Facultad de Ingeniería,*
Av. Industrias no Contaminantes por Periférico Norte S/N,
Apartado Postal 150 Cordemex, Mérida, Yuc., México.

Received 27 June 2024; accepted 9 July 2024

Keywords: Permanent magnet; analytical; field calculation.

DOI: https://doi.org/10.31349/RevMexFisE.21.020701

The magnetic inductions produced by permanent magnets with different geometries (spherical, cylindrical and so on) were calculated in one of our previous works [1]. As an exception, the field outside the symmetry axis for a rectangular prism was taken from another article [2]. However, Vervelidou *et al.* [3] noticed recently that the component B_y of that prism was wrong. The correct expression is given in this manuscript.

The origin of coordinates was taken at the center of the prism, and the body has dimensions $2a \times 2b \times 2c$, measured along the x, y and z axes respectively.

We calculated the induction field $\vec{B}$ by assuming that the magnet consists of a continuous and homogeneous distribution of infinitesimal dipoles with magnetic dipole moment $\mathrm{d}\vec{m} = \vec{M}\mathrm{d}V$, where $\vec{M}$ is the constant magnetization of the magnet, aligned in the z direction. Using Mathematica, we integrated the contributions from the whole magnet and the outside components of $\vec{B}$ resulted to be:

$$B_x = \frac{\mu_0 M}{4\pi} \ln \frac{F_2(-x,y,-z)F_2(x,y,z)}{F_2(x,y,-z)F_2(-x,y,z)}, \tag{1}$$

$$B_y = \frac{\mu_0 M}{4\pi} \ln \frac{F_3(x,-y,-z)F_3(x,y,z)}{F_3(x,y,-z)F_3(x,-y,z)}, \tag{2}$$

$$B_z = -\frac{\mu_0 M}{4\pi} \big[F_1(-x,y,z) + F_1(-x,y,-z) + F_1(-x,-y,z) + F_1(-x,-y,-z) + F_1(x,y,z) + F_1(x,y,-z) + F_1(x,-y,z) + F_1(x,-y,-z)\big], \tag{3}$$

where the functions F_1, F_2 and F_3 are defined as:

$$F_1(x,y,z) = \arctan \frac{(x+a)(y+b)}{(z+c)\sqrt{(x+a)^2 + (y+b)^2 + (z+c)^2}}, \tag{4}$$

$$F_2(x,y,z) = \frac{\sqrt{(x+a)^2 + (y-b)^2 + (z+c)^2} + b - y}{\sqrt{(x+a)^2 + (y+b)^2 + (z+c)^2} - b - y}, \tag{5}$$

$$F_3(x,y,z) = \frac{\sqrt{(x-a)^2 + (y+b)^2 + (z+c)^2} + a - x}{\sqrt{(x+a)^2 + (y+b)^2 + (z+c)^2} - a - x}. \tag{6}$$

We can see that the exchange of the variables $(a,x) \Longleftrightarrow (b,y)$ in Eqs. (5) and (6) results in the exchange of F_2 and F_3, and consequently in the components B_x and B_y, as it should be.

For good, most of the times the component parallel to $\vec{M}$ (B_z in this case) is the most used for being the strongest one. The correction stated here will scarcely change the conclusions of articles citing our work.

1. J. Camacho, V. Sosa, Alternative method to calculate the magnetic field of permanent magnets with azimuthal symmetry, *Rev. Mex. Fis E* **34** (2013) 125. https://rmf.smf.mx/ojs/index.php/rmf-e/article/view/4692/5953.
2. Z. J. Yang, T. Johansen, H. Bratsberg, G. Helgesen, A. T. Skjeltrop, Potential and force between a magnet and a bulk $Y_1Ba_2Cu_3O_{7-\delta}$ superconductor studied by a mechanical pendulum, *Supercond. Sci. Technol*. **3** (1990) 591. https://doi.org/10.1088/0953-2048/3/12/004.
3. F. Verdelidou, B. P. Weiss, F. Lagroix, Hand magnets and the destruction of ancient meteorite magnetism, *J. Geophys. Res.-Planets* **128** (2023) e2022JE007464. https://doi.org/10.1029/2022JE007464.