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Comment on mr-2021-34

Anonymous Referee #2

Referee comment on "Magnetostatic reciprocity for MR magnet design" by Pedro Freire Silva et al., Magn. Reson. Discuss., https://doi.org/10.5194/mr-2021-34-RC2, 2021

This manuscript describes a method based on the reciprocity principle for analyzing and optimizing the design of permanent magnet systems for magnetic resonance (MR) experiments. The authors show that the reciprocity principle for magnetostatics can be used to simplify simulations of the performance of these systems, which are of great interest to people designing MR spectrometers based on permanent magnets. However, while the content of the manuscript will likely be of interest to readers, I feel the material is presented in a way that is somewhat opaque to those not already intimately familiar with the field. I feel the presentation of the content as it stands will present a barrier to understanding for non-experts, and I feel that with some work put into rewriting parts of the manuscript, this paper could be much more impactful.

The paper begins with a description of the reciprocity principle for magnetostatics, and then moves through several examples where the reciprocity principle is used to analyze and/or optimize the performance of an array of permanent magnets. However, as far as I could follow, the manuscript lacked clear and adequate descriptions of the problems they were trying to solve. Part of the confusion stems from the fact that the paper is full of jargon unfamiliar to non-experts which is never defined. I recommend the authors rework the manuscript with an eye towards simplifying the presentation and clarifying the problems they are trying to address. Some particular points of clarification:

- For non-experts, it would be helpful to see some dimensionful units. What are the units of B, for example? How physically large are these arrays? At the end of the manuscript it is explained that all quantities presented are dimensionless, however this should be made clear from the beginning.
- It is not clear to me how Equation 2 as written follows from Equation 1, if M, H, and B are defined as described in the preceding paragraph. Where do the self-interaction terms Ha*Ha and Hm*Hm come from?
- Figure 1:
  - The term “anchor magnet” is never clearly defined in the text.
- Figure 2:
  - What is d_m? It seems either it is not clearly defined, or it is not used with a

consistent definition.
    - Again, for non-experts, it would be helpful to see some dimensionful units here- what is the rough size of the B-field that can be produced by this microarray, for example?
    - What are the colors in Figure 2A) indicating?
    - As far as I can tell, B and C both show different aspects of the design assembled with and without the outer alignment structure, but the caption seems to indicate B and C deal with the two respective cases?
    - 2C is quite confusing to me. Are the d_m and alpha axes correlated? What exactly is being plotted here?
- Figure 3:
    - How is this self-alignment achieved?
    - Is there an intuitive reason why sigma_B shows the structure it does as a function of d_M? It is not clear to me what is being plotted here, what is the relationship between the magnet diameter and the anchor?
- Figure 4:
    - A clearer presentation of the toroidal array would be helpful.
    - What is 4B showing? The caption is unclear, 4B is identified twice. Which plots show what?
    - How large are the T values presented? Again, some feeling for dimensions would be extremely helpful.
- Figure 5:
    - What is 5D showing? What does the red represent? Why is the eta axis non-monotonic?
- There are several different notations used throughout the manuscript. Equations 1 and 2 use one vector notation, Equation 3 uses a second, different notation, Equations 4 and 5 use a third notation, and Equation 9 uses a forth notation.