Independent Research in Applied Mathematics

June 2023

1 An applied measure-theoretic result

In Calderon's problem in electrostatics we come accross Von-Neumann's map which has an inverse $F(\mathbf{x})$ which is given by

$$F(\mathbf{x}) = \left(\frac{\|\mathbf{x}\|}{2} + 1\right)\frac{\mathbf{x}}{\|\mathbf{x}\|} \tag{1}$$

This is simplified to

$$F(\mathbf{x}) = \mathbf{x}\left(\frac{\|\mathbf{x}\| + 1}{2\|\mathbf{x}\|}\right) \tag{2}$$

which can be expressed as

$$F(\mathbf{x}) = \alpha\mathbf{x} \tag{3}$$

where at $\mathbf{x} = 0$, $F(\mathbf{x}) = \frac{\mathbf{0}}{0}$.
However, $\mathbf{0}$ is a point in, say, 3 dimensions, and 0 is a point in 1 dimension. Therefore, $\mathbf{0}$ has greater measure than 0. So, a is a point and not a singularity. Therefore,

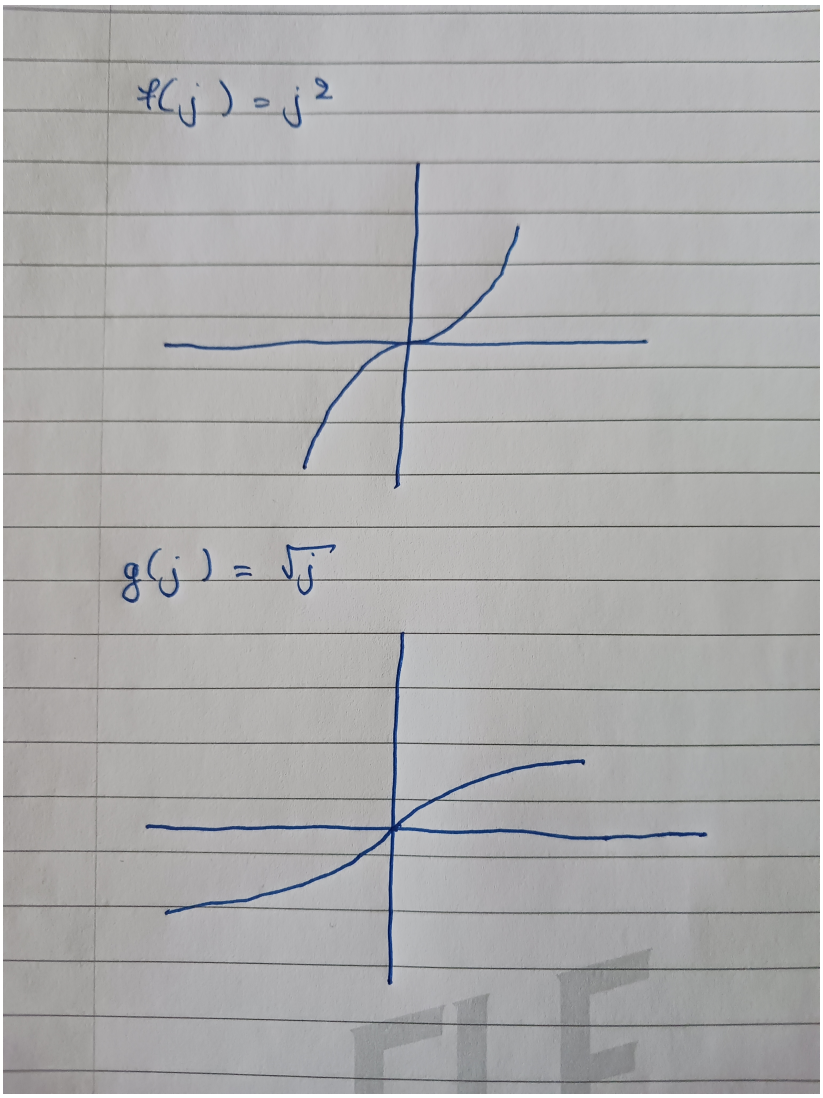
$$F(\mathbf{x} = \mathbf{0}) = 0 \tag{4}$$

2 An applied number-theoretic result

We can define a number system in the following way

$$\mathbf{J} = \{xj,\ x \in \mathbf{R} | \sqrt{j} = -1 \text{ and } j^2 = -1\} \tag{5}$$

Then we can define $f(j) = j^2$ and $g(j) = \sqrt{j}$.



We see that $f(j) < x^3$ and $g(j) < x$, so smaller perturbations are thus given.

3 An applied classical physics result

There are equations for the magnetization and the electric element which are less-known and are given by

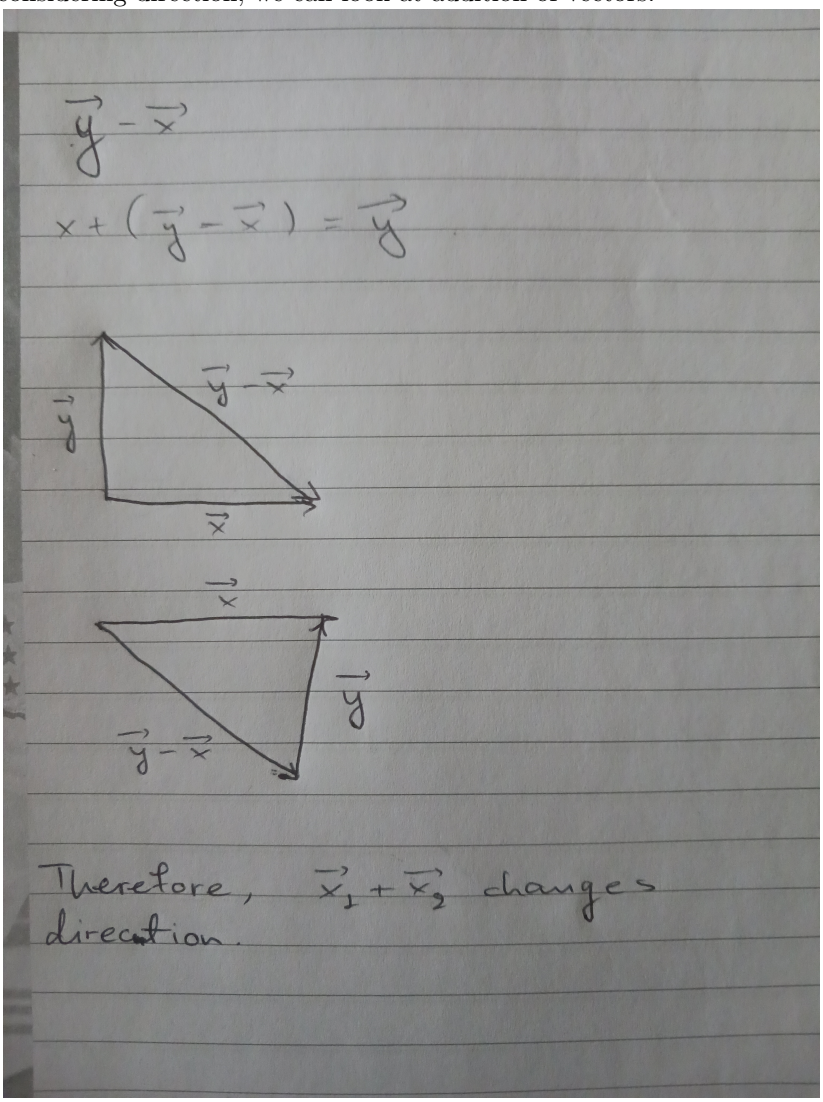
$$\mathbf{m} = \mathbf{s} \times \mathbf{B} \tag{6}$$

$$\mathbf{e} = \mathbf{j} \times \mathbf{E} \tag{7}$$

where s is the spin, j the current element, and E and B the electric and magnetic fields.

4 An applied geometric result

In considering direction, we can look at addition of vectors.



Using this, we can prove, for instance, that $[0,1] + [0,1] = [0,2)$, since we can add two vectors on the real line and the direction changes.