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Associating disconnectedness with electromagnetic phenomena

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ABSTRACT

A seemingly unique interpretation of the concept of disconnectedness is discussed. It is then used to simplify an analysis of several well-known physical phenomena related to electromagnetism.

1. Disconnectedness

The concept of disconnectedness can be demonstrated in a straightforward fashion. Given a set of eight cubes of equal side length, two very different adjacency configurations are illustrated in Fig. 1. On the left the cubes have been arranged in a single line, resulting in a total surface area of $A = 2 \times 5 + 6 \times 4 = 34$ units, and a total volume of $V = 8$ units. On the right, the cubes have been arranged in the form of a larger cube, resulting in a total surface area of $A = 8 \times 3 = 24$ units, and a total volume of $V = 8$ units. Clearly, the configuration on the right has a greater number of shared faces, implying a greater measure of connectedness. That said, connectedness is taken to be:

$$\sigma = \frac{V}{A}, \tag{1}$$

and so disconnectedness is taken to be equivalent to specific surface area (*sans* density):

$$\zeta = \frac{1}{\sigma} = \frac{A}{V}. \tag{2}$$

This results in a measure of connectedness $\sigma = 8/34 \approx 0.235$ for the configuration on the left, and a measure of $\sigma = 8/24 \approx 0.333$ for the configuration on the right.

On the other hand, the object under analysis does not necessarily have to be entirely path-connected like with the two configurations shown in Fig. 1. As illustrated in Fig. 2 where $\sigma = 8/48 \approx 0.166$, an object may consist of many spatially separated pieces, and yet still be described by only one *total* volume and one *total* surface area.

2. Disconnectedness and linear momentum

For a 3D ball of radius r and constant positive Gaussian curvature K [1], the equations related to connectedness are:

$$V = \frac{4}{3}\pi r^3, \tag{3}$$

$$A = 4\pi r^2, \tag{4}$$

$$\sigma = \frac{r}{3}, \tag{5}$$

$$r = 3\sigma = \sqrt{\frac{1}{K}} = \frac{3}{\zeta}. \tag{6}$$

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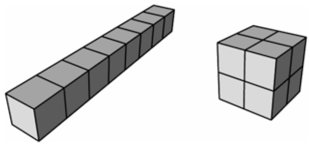

Fig. 1. Two different adjacency configurations for eight path-connected cubes, resulting in two different measures of connectedness. Left, $\sigma = 8/34 \approx 0.235$; right, $\sigma = 8/24 \approx 0.333$.

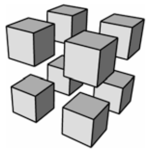

Fig. 2. The eight cubes in this configuration are all path-disconnected (e.g., none are adjacent). $\sigma = 8/48 \approx 0.166$.

As the ball's radius and connectedness increase without limit, Gaussian curvature and disconnectedness (specific surface area) vanish.

As explained throughout the remainder of this section, it seems reasonable to associate the concept of disconnectedness with a particle of light or a moving particle of matter via its linear momentum p. Where h is Planck's constant, and λ represents either photon or de Broglie wavelength:

$$\lambda = 2r = \frac{h}{p}, \tag{7}$$

$$\zeta = \frac{6}{\lambda}. \tag{8}$$

The following is an analysis of a few well-known physical phenomena [2,3] from the perspective of disconnectedness:

1. A particle of light represents energy–momentum that has escaped (e.g., has become disconnected from) its massive emitter. The smaller a photon's wavelength, the greater the energy–momentum it has, and the greater a disconnection it represents.
2. The disconnectedness associated with a photon is also demonstrated when it is absorbed by a massive particle. In the photoelectric effect, the disconnectedness of a photon must overcome the attractive electrostatic connection between an electron and the metal surface along which it resides (assuming that the electron undergoes no collisions on the way out). If the photon's disconnectedness is not enough to overcome this attractive connection, the absorbing electron is not ejected. On the other hand, if the electron is successfully ejected, the remaining disconnectedness is carried along with the electron in the form of linear momentum. That is, the greater the energy–momentum of a photon, the greater its ability to disconnect.
3. In terms of basic electrodynamics (e.g., special relativity), the disconnectedness of a moving system of matter is fundamentally related to kinematic time dilation. The more time dilated the system is, the more the system's internal processes have become preempted by motion in a unified direction. At $v \sim c$, disconnectedness is nearly infinite, and the system's internal processes are all but non-existent – all connections between the constituents of the system have all but disappeared. Of course, the notion of the ability to disconnect also applies here, which can be demonstrated by throwing a baseball through a glass window.
4. Considering a telecommunications circuit consisting of both photonic and electronic components to be an ideal example of what one would consider to be a connection, it seems then that a transmission of energy–momentum such as this is actually a stream of disconnectedness. This notion seems to be confirmed when considering the stream of photons used in laser eye surgery, or the stream of matter used in waterjet cutting.
5. Considering the photoelectric effect from a perspective compatible with the notion of "stream of disconnectedness", it seems the attractive electrostatic connection responsible for binding an electron to the metal's surface is actually due to a field of disconnectedness.
6. An increase in the temperature of an ideal gas occurs alongside an increase in the average linear momentum of its constituent particles. Also, as demonstrated by Planck's law, the total amount of energy emitted as photons by a blackbody increases as its temperature increases. It seems then that the disconnectedness of a material system increases alongside temperature. In terms of a pragmatic example, it is generally easier to clean one's supper dishes (e.g., dissolve solids and liquids) using hot water rather than cold water.

3. Discussion

From this brief sketch alone it seems that disconnectedness has the potential to play an important role in future theory, given that it allows one to describe several aspects of physical reality (e.g., linear momentum, time dilation, temperature)

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using a single concept. To imagine this potential importance in the most extreme of terms, it also seems that a multiparticle universe like the one we live in could not occur without the very existence of disconnectedness.

Of course, it may be argued that such an association is trivial (e.g., well-known) due to its sheer simplicity. However, the likelihood of this seems low since this association was discovered directly through the study of fractal geometry [4], but yet a notably large number of professional physicists and mathematicians abhor the work of anyone who would imply that fractal geometry is even remotely useful in the study of physics. If this association were indeed trivial, then the current hostility toward those with interest in fractal geometry would simply not exist. Additionally, anyone working on categorifying physics would have already documented this association long ago if it were well-known, given the fundamental importance of topological connectedness in their work. However, this does not appear to be the case, given that the word disconnectedness is absent from Refs. [5–7].

It is important to note that the term "novel" only applies to the inherently non-fractal context used here in this manuscript, for the use of disconnectedness by mathematical physicists relying directly on fractal geometry to model physical reality has been a common occurrence for over 40 years [8].

Modern fractal-centric perspectives related to this discussion can be found in [9–11].

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