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Maximum Mass-Particle Velocities in Kantor's Information Mechanics

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Kantor's information mechanics links phenomena previously regarded as not treatable by a single theory. It is used here to calculate the maximum velocities v_m of single particles. For the electron, $v_m/c \approx 1 - 1.2538\underline{14} \times 10^{-77}$. The maximum v_m corresponds to $v_m/c \approx 1 - 1.0978\underline{64} \times 10^{-122}$ for a single mass particle with a rest mass of $3.078\underline{496} \times 10^{-5}$ g. This is the fastest that matter can move. Either information mechanics or classical mechanics can be used to show that v_m is less for heavier particles. That v_m is less for lighter particles can be deduced from an information mechanics argument alone.

Kantor's information mechanics (Kantor, 1977; hereinafter cited as IM) is a physical theory that provides a context in which to discuss previously thought dissimilar phenomena, such as the fine structure constant (on the scale of the very small) and cosmological red shift (on the scale of the very large). More recently information mechanics has suggested a method of using software to make hardware for information processing (Kantor, 1982).

To address the question of maximum velocities of particles, I use Kantor's notion of a B_0 (IM, Definition 6, p. 43, and A-Definition 12, p. 189). A B_0 is a soft box (IM, Definition 5, and pp. 43–44) without mass that contains two photons with opposite momenta in the lowest state of the box when the box is substantially at rest. The soft box is in a large but finite enclosure (universe U). The total photon energy of the B_0 in its rest frame is E_0: $E_0 = 2hf_0$, where f_0 is the frequency of each photon as determined by an observer moving with B_0. As the B_0 moves, one photon is upshifted, frequency f_+, the other downshifted, frequency f_-.

Because a composite object cannot go faster than its slowest piece, a discussion of a single B_0 suffices.

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By combining the equations in IM, Table 2, p. 155, the energy of the lowest photon state in U, E_1, and the total accessibility of information in U, I_U, can be expressed in terms of four input parameters:

1. Gravitational constant, $G \approx 6.6720 \times 10^{-11}\ \mathrm{m^3/kg\,sec^2}$
2. Electron rest mass, $m_e \approx 9.109534 \times 10^{-31}$ kg
3. Speed of light, $c \approx 2.99792458 \times 10^{8}$ m/sec
4. Reduced Planck constant, $\hbar \approx 1.0545887 \times 10^{-34}$ J sec (Cohen and Taylor, 1973)

One has

$$E_1 \approx Gm_e^3F^3c/3.6\hbar \approx 1.0249\underline{66} \times 10^{-52}\ \mathrm{J}$$

$$\approx 6.397\underline{28} \times 10^{-34}\ \mathrm{eV}$$

$$I_U \approx (c\hbar/Gm_e^2F^2)^3(3.6)^2 \approx 3.643\underline{44} \times 10^{122}\ \text{bits}$$

(Underlined digits indicate that precision is carried because these numbers are not statistically independent.) The intermediate value F is calculated by solving the following information mechanics exponential equation (IM, p. 147): $F^3 \exp(F^3/32\pi^2)^{1/2} \approx 7.2\hbar c/m_e^2G$. ($F$ differs from the inverse fine structure constant by less than 20 parts per million.)

The equations (a) and (j) derived in A-Corollary 2.1 (IM, pp. 194-202) are used here to calculate the maximum possible velocity v_m for a single mass particle with rest energy E_0. Equation (a) gives the frequencies: $f_\pm = f_0(1-v^2/c^2)^{1/2}/(1\mp v/c)$. Solving for v/c for the lower set of signs and substituting energy gives

$$v/c = [1-(2n_-E_1/E_0)^2]/[1+(2n_-E_1/E_0)^2]$$

where n_-, an integer, is the number of times the downshifted photon fits in U. The greatest velocity a B_0 can attain is governed by the boundary condition that the wavelength of the downshifted photon fit in U exactly once (IM, "fastest B_0", Definition 14, p. 83). Then $n_- = 1$ and

$$v_m/c = [1-(2E_1/E_0)^2]/[1+(2E_1/E_0)^2]$$

Applying this to the electron, with $E_0 = 5.1100337 \times 10^{5}$ eV, the rest energy of the electron (Cohen and Taylor, 1973), one finds

$$v_m/c = (1-6.26\underline{907} \times 10^{-78})/(1+6.296\underline{07} \times 10^{-78}) \approx 1-1.2538\underline{14} \times 10^{-77}$$

Reexpressing equation (j) (IM, p. 195) in energy units and solving for the energy E_+ for the upshifted photon, one finds $E_+ = E_0^2/4E_1$, which for the electron would be $1.0204\underline{51} \times 10^{44}$ eV.

A related question is the determination of the heaviest single mass particle that can have its downshifted photon fit in U exactly once. An upper bound can be calculated by attributing half the energy in U to the moving particle, where the factor one-half is to conserve momentum in U. From equation (j), $E_0 = 2(E_1 E_+)^{1/2}$. One has $E_+ = E_1 I_+$, where I_+ is the number of bits associated with the upshifted photon. Here $I_+ = I_U/2 - 1$. Since $I_U \gg 1$,

$$E_0 \approx E_1(2I_u)^{1/2} = 1.726\underline{896} \times 10^{28}\ \mathrm{eV} = 2.766\underline{814} \times 10^9\ \mathrm{J}$$

Solving $E_0 = m_0 c^2$ for m_0, the rest mass of the particle, gives $m_0 = 3.078\underline{496} \times 10^{-8}$ kg. This corresponds to

$$v_m/c = (1 - 5.489\underline{32} \times 10^{-123})/(1 + 5.489\underline{32} \times 10^{-123}) \approx 1 - 1.0978\underline{64} \times 10^{-122}$$

which is the fastest that matter can move. A more massive B_0 must move slower because of the restriction on the amount of energy available as energy of motion. A less massive B_0 moves slower because of the condition on the wavelength of the downshifted photon. It is the intersection of these two effects that leads to a maximum.

Information mechanics has been used to calculate a maximum limit for mass-particle velocities. For the first time it has been possible to quantify the idea that moving matter must have a velocity less than that of light.

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