Why masses attract each other?

It is well known that electrons repel each other and masses attract each other. This is shown below by looking at this in an alternative way, namely through the potential energy around charged objects (electrons and protons) and masses.

An object will always move from a high potential energy to a low potential energy. This is the starting point to look at how it is possible that electrons repel each other, electrons and protons attract each other, to use this to find out that masses attract each other.

How electrons repel each other

The repulsive effect between electrons is usually explained by the fact that electric fields give a certain pattern. See Appendix 1. However, I will use a different route, namely by looking at the energy difference around a charged object. In addition to electric fields, charged objects as electrons also give electrical voltages. The latter is a well-known concept in physics, the so-called equipotential planes. The voltage at a certain point can be calculated via de formula $U = \frac{q}{4\pi x^2}$ [V], with $x\ [m]$ and $q\ [C]$.

Suppose on the left in figure 1 a quantity of electrons, called charged objects, with -10 C. A little further to the right are other charged objects, also with -10 C. The voltages will now decrease with respect to the relevant charged objects around them according to the square law (blue). For simplicity, only the effect on the left is included in figure 1. The numbers mentioned are estimated very roughly and certainly not formal proof. They are only meant to understand what is happening with the energy around the charged objects.

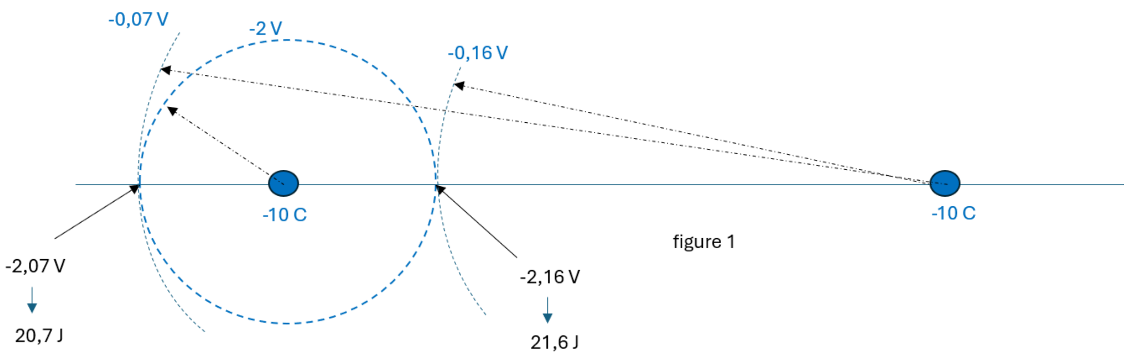


figure 1

The voltages of both charged objects can be added together (black). Of these, only the values are given on the 'x-axis' between the charged objects themselves. The y- and z-axes are not important because they cancel each other out. Since $E = qU$ we get 20.7 J to the left of the left charged objects and 21.6 J to the right of the same charged objects. Because 20.7 J < 21.6 J the left charged objects will be pushed to the left. The charged objects on the right will therefore want to move to the right for the same reason. The charged objects therefore repel each other.

If we do the same with electrons as charged objects on the left and protons as charged objects on the right, we get the values as shown in figure 2 for similar numbers.

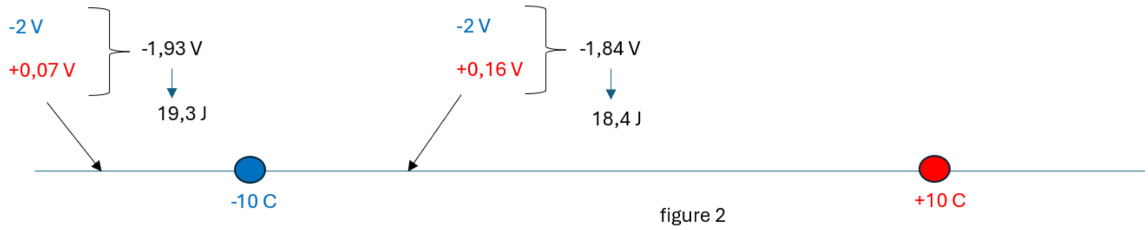


figure 2

The left charged objects will now want to move to the right because 19.3 J > 18.4 J and vice versa the right charged objects will want to move to the left if we take the same setup for those charged objects. Both charged objects therefore want to move towards each other.

How masses attract each other

To make the step to masses, first it must be considered that the above-mentioned charged objects are supplied with energy by, for example, an external voltage source. This is seen as **negative** energy from a mathematical point of view. See Appendix 2.

According to Einstein's well-known formula $E = mc^2$, there is energy around a mass according to the same formula, decreasing in strength according to the square law. This then forms the space of the spacetime in the General Theory of Relativity as described by Einstein. See Appendix 3.

However, if a mass with $E = mc^2$ is formed, then there must also be negative energy with value $E = -mc^2$ to 'supply' that energy. This negative energy is around the masses.

When there are 2 masses, we get the following simplified picture with similar numbers in figure 3 as above.

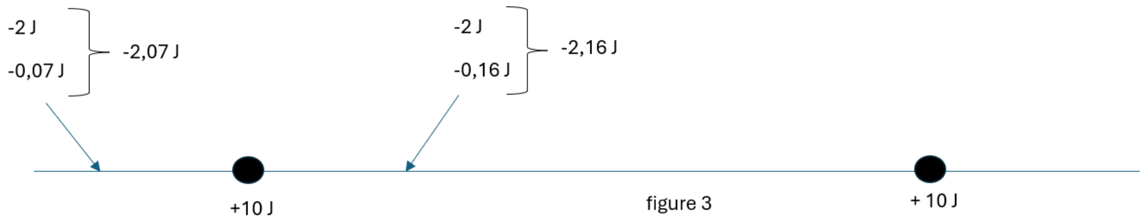


figure 3

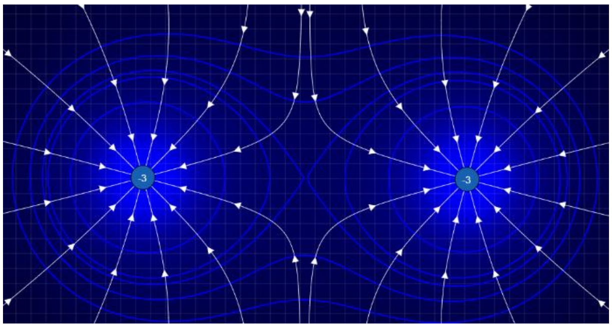
Since -2.07 J > -2.16 J, the left mass will want to move to the right and the right mass will want to move to the left for the same reason. So, both masses want to move towards each other.

Note: If there was already positive or negative energy without mass, then the above explanation remains the same, because (A - 2.07) > (A - 2.16) with $A \epsilon R$.

Bram Steennis, 3 April 2025

Appendix 1

If we have 2 charged objects [C], not only the electrical field lines can be displayed, but also how the voltages between charged objects are distributed. The so-called equipotential planes. In the 2-D simulation below, this is shown as the white field lines and blue equipotential lines for the situation on the left 3 negative charged objects and on the right also 3 negative charged objects.



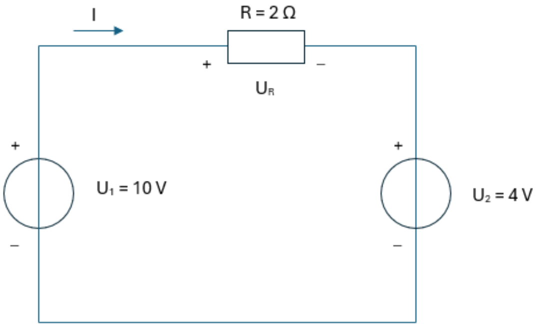
The electric field lines are vectors that determine the pattern of the white lines.

The voltages are not vectors but scalars. The equipotential plane is therefore the sum of the voltages of both charged objects.

E-Field Simulation

Appendix 2

The following is an indication of how the concept of negative power (= energy per second) is dealt with in electrical engineering. Negative power is purely mathematical to be able to calculate how the powers are distributed. See the electrical diagram on the right.



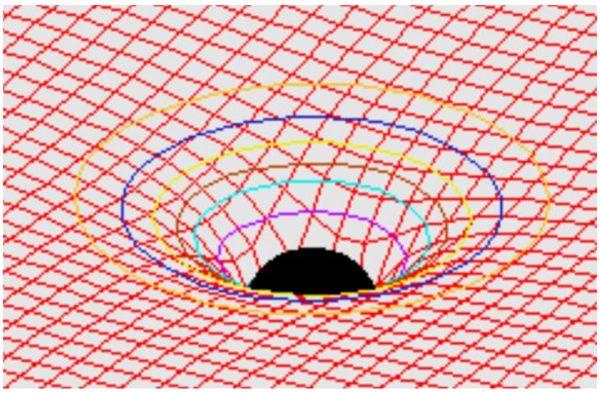
According to the method of Kirchhoff's 2nd law, when adding the voltages walking around in the total circuit, we now get: $+10 - U_R - 4 = 0$, so $U_R = 6\ V$. Therefore, according to Ohm's law, the current $I = \frac{U_R}{R} = \frac{6}{2} = 3\ A$.

The powers per component can be found by using the formula $P = U * I \quad [W]$, where the following generally accepted rule applies: where the current arrow I goes in the component, the sign determines that we include in the calculation of the power. That is plus at the resistor R = 2 Ω and the source U = 4 V and it is a minus at the source U = 10 V. We now get $P_{10V} = -10 * 3 = -30\ W$, $P_R = +6 * 3 = +18\ W$ and $P_{4V} = +4 * 3 = 12\ W$. The sum of the powers is = 0.

Conclusion: The 10 V source has a power of –30 W. This means that this source delivers 30 W power. This power is absorbed by the resistor of 2 Ω with +12 W and the source of 4 V with +18 W.

Appendix 3

The imaging of spacetime in relation to a mass in Einstein's General Theory of Relativity.



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