A square sheet of aluminum foil is considered 2-dimensional because its mass is proportional to its diameter to the power of 2. A solid aluminum sphere is considered 3-dimensional because its mass is proportional to its diameter to the power of 3. An aluminum wire is considered 1-dimensional because its mass is proportional to its length. The mass is proportional to length to the power of 1. From these three examples we conclude that the relation $\text{Mass} \sim \text{Diameter}^{\text{Dimension}}$ would be a simple and good definition of dimension for homogeneous solids, where the Diameter is the largest diameter of the object.

However, when we take a closer look at the aluminum foil we notice that it has a non-zero thickness and if the diameter of the sheet is small and close to the thickness of the sheet it looks like a small cube of aluminum. On that scale, its shape is similar to a solid aluminum sphere and therefore 3-dimensional. We conclude that the dimension of an object may be different on different scales.

Therefore it is more useful to define the dimension of an object slightly differently. The dimension of a solid with constant density, describes how much the mass of an object increases if we increase its diameter by a small amount. The change in mass is given by the equation

$$\text{Mass-change} \sim \text{Diameter}^{\text{Dimension} - 1}$$

Figure 1 illustrates this relationship. For example, if we increase the diameter of a 2-dimensional object by a small amount, the additional mass is proportional to the length of the object perimeter (see Fig. 1b). Because the perimeter is proportional to the object diameter, we find: $\text{Mass-change} \sim \text{Diameter}$. This is consistent with Eq. (1). If the diameter of a 3-dimensional object is increased by a small amount, the additional mass is proportional to area of the object surface (see Fig. 1c). Because the object surface is proportional to the square of the object diameter, we find: $\text{Mass-change} \sim \text{Diameter}^{2}$. This is consistent with Eq. (1). Fractal objects have non-integer dimensions [1-5]. Figure 1d shows a fractal solid with dimension $D = 1.5$. Its mass grows not as fast as that of a 2-dimensional object, but faster than for a 1-dimensional object: $\text{Mass-change} \sim \text{Diameter}^{0.5}$. 
Figure 1 illustrates that solid objects can have dimension 1, 2, and 3 and fractal dimensions between 1 and 3, but could they have negative dimensions? A negative dimension would require that the mass-change would decrease as a function of the diameter in contrast to 1-3 dimensional objects (see. Eq. 1). A star shaped object as shown in Figure 2 has negative dimension, dimension \( D = -0.4 \) [6].

The dimension of an object is important for understanding how things spread. For instance, if a current source is at the middle of a wire, half of the currents flows on each side, but the current on each side is constant, independent from the distance to the source. In contrast if a current source is placed in the middle of a sheet of aluminum foil, the current spreads equally in all directions and decreases with the distance to the source. The current is proportional to \( 1 / distance \). If there is a current source in the middle of an aluminum sphere, the current spreads evenly in all directions and decreases even faster as a function of the distance from the source, the current is proportional to \( 1 / distance^2 \).

Heat and diffusion particles spread in the same way. Even waves, such as sound and light, spread in the same way except that the interference of the waves adds more structure. These spreading processes have one property in common: The thing-which-spreads spreads from each location equally to all neighboring locations. If there are more neighbors further away from the center of the object, then the thing-which-spreads mostly moves away from the center. For instance, if some charges are placed at a certain distance from the center of an aluminum foil, most of the charges are moving away from the center of the object, because there is more aluminum foil further away from the center, according to Eq. 1. In contrast, if we make a star shaped object, as shown in Fig. 2, out of aluminum foil and place some charges at a certain distance from the center, most charges move toward the center, because there is more aluminum foil closer the the center (see Fig. 1e), according to Eq. 1. Similarly, if a certain amount of heat, diffusion particles, electrical charges, or sound are placed a given distance away from the center of a negative dimensional object, most of it moves toward the center. In contrast, in solids with a positive dimension between 1 and 3 an amount of heat, diffusion particles, electrical charges, or sound, placed at a distance from the center, move mostly away from the center.

There are probably more abstract objects which obey Eq. 1. For instance, the locations of all people in a city may be a set of points which matches Eq.1. At small distances from the center there are many people, whereas in the surrounding rural areas there are very few. Let us assume that the set of people locations is a negative dimensional object. If we further assume that an infectious deease spreads quickly from person to person, more quickly than people travel, then an infection that starts at a distance from the center of city would mostly spread towards the center of town. This is because there are more people closer to the center of city than further away.

In summary, solids and more abstract objects can have a negative dimension. The dimension of an object determines how heat, diffusion particles, electrical charges, and infections spread. In objects with a dimension between 1 and 3 there is a tendency to move away from the center of the object. In contrast, in objects with a negative dimension there is a tendency to move toward the center of the object.
Figure 1. The current solid (white, blue and gray mass) and the additional mass (red) if the diameter is increased for solids with dimension $D=1,2,3, 1.5$ and $-0.4$. For dimensions between 1 and 3 the additional mass is larger for objects with a larger diameter. For objects with a negative dimension the additional mass is less for objects with a larger diameter. If something-spreads is placed in the gray area, the blue neighbors are closer to the center and the red neighbors are further away. Objects with a dimension between 1 and 3 have more red mass than blue mass. Therefore things spread outward. Negative dimensional objects have less red mass than blue mass. Therefore things move towards the center.
Figure 2. A solid with dimension $D = -0.4$.