MAXWELL ON HIS DEMON

Letter from Maxwell to Peter Guthrie Tait, December 11, 1867[a]

Cambridge University Library, Maxwell Collection, Maxwell-Tait Correspondence.

I do not know in a controversial manner the history of thermodynamics, that is, I could make no assertions about the priority of authors without referring to their actual works. If I can help you in any way with your book I shall be glad, as any contributions I could make to that study are in the way of altering the point of view here and there for clearness or variety and picking holes here and there to ensure strength and stability.

As for instance I think you might make something of the theory of absolute <temp> scale of temperature by reasoning pretty loud about it and paying it due honour, at its entrance. To pick a hole—say in the 2^{nd} law of θ^{cs} [thermodynamics] that if two things are <at the same temperature> in contact the hotter cannot take heat from the colder without external agency.

Now let A & B be two vessels divided by a diaphragm and let them contain elastic molecules in a state of agitation which strike each other and the sides.

Let the number of particles be equal in A and B but let those in A have greatest energy of motion. Then even if all the molecules have equal velocities, if oblique collisions occur between them their velocities will become unequal, and I have shown that there will be velocities of all magnitudes in A and the same in B, only the sum of the squares of the velocities is greater in A than in B.

When a molecule is reflected from the fixed diaphragm CD no work is lost or gained.

If the molecule instead of being reflected were allowed to go through a hole in CD no work would be lost or gained, only its energy would be transferred from one vessel to the other.

Now conceive a finite being who knows the paths and velocities of all the molecules by simple inspection but who can do no work except open and close a hole in the diaphragm by means of a slide without mass.

Let him first observe the molecules in A and when he sees one coming the square of whose vel.[ocity] is less than the mean sq. [square] velocity of the molecules in B let him open the hole and let it go into B. Next let him watch for a molecules of B, the square of whose velocity is greater than the mean sq. [square] vel. [velocity] in A, and when it comes to the hole let him draw the slide and let it go into A, keeping the slide shut for all other molecules.

Then the number of molecules in A and B are the same as at first, but the energy in A is increased and that in B diminished, that is, the hot system has got hotter and the cold colder and yet no work has been done, only the intelligence of a very observant and neat-fingered being has been employed.

Or in short if the heat is the motion of finite portions of matter and if we can apply tools to such portions of matter so as to deal with them separately, then we can take advantage of the different motion of different proportions to restore a uniform hot system to unequal temperatures or to motions of large masses.

Only we can't, not being clever enough.

Letter from Maxwell to Peter Guthrie Tait (undated) "Catechism on Demons"

C. G. Knott *Life and Scientific Work of Peter Guthrie Tait* (Cambridge: Cambridge University Press, 1911), 214–215.

Concerning Demons

1. Who gave them this name? Thomson.
2. What were they by nature? Very small **BUT** lively beings incapable of doing work but able to open and shut valves which move without friction or inertia.
3. What was their chief end? To show that the 2nd Law of Thermodynamics has only statistical certainty.
4. Is the production of an inequality of temperature their only occupation? No, for less intelligent demons can produce a difference in pressure as well as temperature merely by allowing all particles going in one direction while stopping all those going the other way. This reduces the demon to a valve like that of the hydraulic ram, suppose.