LOSCHMIDT

Thanks for mentioning the "irascible" Douglas Cotton, who was a contemporary of mine at the University of Sydney's School of Physics in the 1960s.

I don't mind his illogical reasoning, which is obvious enough to simply ignore. What really annoys me is that he's given Josef Loschmidt's little-known "gravito-thermal" theory as he calls it a bad name by association with his reasoning, claiming illogically that it disproves global warming.

Loschmidt argued that gravity could account for lapse rate in the atmosphere by molecules having slightly less energy when they rose in between molecular collisions, and slightly more when they fell. I believe Boltzmann accepted that but did not accept Loschmidt's further claim that entropy did not need to increase when the atmosphere grew cooler with altitude. Boltzmann argued that the probability of it not increasing was so tiny that it was immaterial.

Had I been in Loschmidt's shoes, I would have contradicted Boltzman by pointing out that there is no flow of heat in Loschmidt's theory, hence nothing intrinsically in the motion of the air molecules to increase entropy, making the probability of it not increasing essentially 1 in any small neighborhood.

Maxwell had a different argument against Loschmidt. He claimed that in a column of air having no bulk motion but only the thermal motions of individual molecules, diffusion would distribute heat evenly, resulting in a zero lapse rate. My understanding today is that Maxwell's argument is controversial. For one thing, how can diffusion distribute heat uniformly between bottom and top when gravity is constantly giving the downward flow of heat, in the form of translational energy of molecules, a boost while simultaneously hindering its upward flow?

As confirmation, consider the circuitous reasoning in the Wikipedia article on lapse rate showing that temperature decreases linearly with altitude: it has to deal with the fact that pressure is not linear with altitude but decreases as its log. Noting that the mean energy of the molecules of a gas is linear with temperature, and that (over a few km) kinetic energy of a ball thrown upwards decreases linearly with altitude (the PE increases as mgh, to a fair

approximation within the atmosphere), the fact that temperature is linear with altitude is a more immediate consequence of Loschmidt's account.

In fact we can ask how high a ball would rise if thrown up in a vacuum with velocity v = 508 m/s. This is the RMS velocity of a molecule of air at 25 °C. Solving $mgh = \frac{1}{2}mv^2$, we obtain $h = v^2/2g$ = 13,090 m. The scale height of Earth's atmosphere at 25 °C is 8,700 m, almost exactly ⅔ of 13,090 FWIW.

.I would take Loschmidt's argument a step further, namely to solids such as make up the Earth. Unlike gases, where the molecules take a random walk, the nuclei of the molecules in a solid are locked into a lattice, whether crystalline or amorphous. Einstein in 1907, and subsequently Peter Debye in 1912, pointed out that the heat of a solid is manifested by the vibrations of its nuclei. Although their detailed calculations involved quantum mechanics, the Hamiltonian in Schrödinger's equation can still include the gravitational potential. While far smaller than the electrostatic potential governing electron orbitals in the Hamiltonian, it can nevertheless shift the probabilities slightly.

Loschmidt's reasoning about the vertical component of gas molecules would appear equally applicable to that of the nuclei of the molecules in a solid. And just as the temperature gradient in a gas results from gravity, why should the same mechanism not apply to heat in the form of the vibrational energy of nuclei?

One consequence would be that entropy is not increasing in Earth's interior anywhere near as fast as Boltzmann imagined, since the gradient is not the result of heat flowing from below to above but rather a purely mechanical side effect of gravity involving no flow from hot to cold. Flows in magma chambers would certainly see substantial increases in entropy, but not in the more solid parts of the Earth. Kelvin calculated that any such flow should send most of Earth's heat to space within 50 million years, making such a large increase in entropy over 4.4 billion years unsustainable unless Rutherford's explanation of geothermal heat was the dominant one.

Another consequence would be that every asteroid would have a warm core. The interior of asteroids that have around for billions of years could only have remained warm either by Rutherford's radioactivity or Loschmidt's account. The former would surely require a huge store of radioactive material!

It would be interesting to know the temperature at the center of the asteroid Ceres, recently promoted to dwarf planet. Its radius is 476 km, surface gravity 0.28 m/s^2, and surface temperature 167K. The 2014 paper

 https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2014JE004714

proposes two scenarios. In scenario (a), 385K is reached while in scenario (b) it is 550K.

That's a gradient of 0.47K/km in (a) and 0.82K/km in (b). If confirmed by other means, that should refute Loschmidt's theory because even at the halfway mark, gravity of 0.14 m/s^2, temperature of say 360K in (b), surely 0.82K/km would be far too small for Loschmidt's theory.

But now let's suppose Loschmidt is right and Ceres' core temperature is actually say 1000K. Then the argument for a much lower core temperature than that has the problem of depending on a high heat flow. With Loschmidt's theory there is no such heat flow since gravity alone can account for the higher thermal gradient.