IS SOUND A PROPERTY OF SPACE?

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APS March Meeting 2009

March 16-20, 2009, Pittsburgh, Pennsylvania

INTRODUCTION

- We are able to distinguish every material from the other by its properties.
- We attribute many different sorts of properties to SPACE.
- SPACE as a physical object only makes sense if it can be detected, or if it can exert physical influences.
- We will try to explore the properties of space if it exists as a material!
- In this talk an attempt is made to prove that space in fact is a Material medium.
- And Sound is a property of Space.
- Statistical Mechanics is used as a tool.

BOLTZMANN

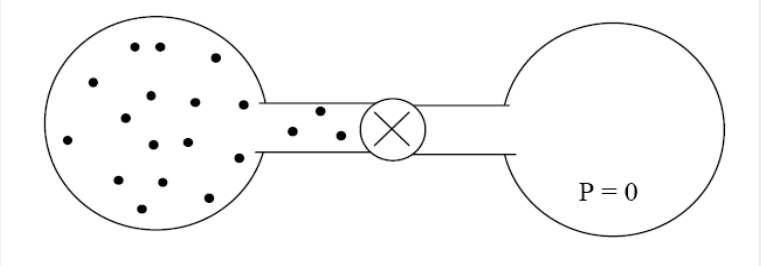
- In 1877, Boltzmann visualized a probabilistic way to measure the entropy of an ensemble of ideal gas particles, in which he defined entropy to be proportional to the logarithm of the number of microstates such a gas could occupy.
- $S = k \ln \Omega$

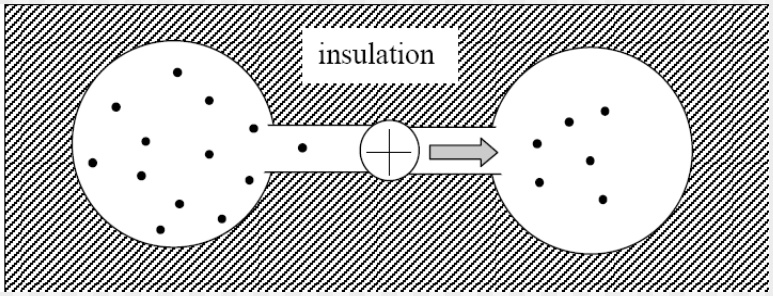
Spontaneous Process -1

- Initially have an isolated system containing mixture of hydrogen and oxygen gases.
- Although hydrogen and oxygen react to form water, in the absence of a catalyst the reaction is so slow that we can ignore it.
- Add a small amount of catalyst to the system and the gases combine to form water.
- Thus the addition of a small amount of catalyst makes all the energy states associated with water molecules available or accessible to the system.
- Since the originally accessible states are still accessible (there is still some hydrogen and oxygen in the system) this spontaneous process is associated with an increase in the number of states accessible to the system.

Spontaneous Process – 2

- Consider a typical spontaneous process, such as the expansion of an Ideal gas into a vacuum under isolated conditions.
- After removing the barrier the gas occupies both the chambers.
- Final Volume is double the initial volume.





Degeneracy

- For an N-particle system the degeneracy can be proved to be $\Omega(E, \Delta E)$ proportional to $(V)^N$.
- For the process illustrated above the gas goes from a thermodynamic state of energy E, number of particles N, and volume V to one with the same energy E, the same number of particles N, but with the volume 2V.
- Thus the number of quantum states available or accessible to the system have increased.

Comparison

- In the first spontaneous process an addition of a catalyst (a material medium) has increased the number of states.
- In the second spontaneous process an addition of empty volume (?????) or space has increased the number of states.
- So, is the space or vacuum a material medium?

IS SPACE A MATERIAL MEDIUM?

- I believe it to be!
- If so like every other medium there should be properties associated with the space.
- Let us see if sound could be its property.

SOUND PROPAGATION AND SPACE

- Propagation of sound in a medium is an irreversible adiabatic process.
- Why is the propagation of sound an adiabatic process?
- Why does not sound propagate in vacuum or free space?

VIBRATIONS

- The mechanical vibrations that can be interpreted as sound are able to travel through all forms of matter: gases, liquids, solids, and plasmas. The matter that supports the sound is called the medium. Sound cannot travel through vacuum.

POTENTIAL AND KINETIC ENERGIES

- Matter in the medium is periodically displaced by a sound wave, and thus oscillates. The energy carried by the sound wave converts back and forth between the potential energy of the extra compression (in case of longitudinal waves) or lateral displacement strain (in case of transverse waves) of the matter and the kinetic energy of the oscillations of the medium.

ADIABATIC PROCESS AND SPACE

- Before the sound propagation the molecular motion of the gas molecules in equilibrium did not produce any sound AND $\Delta s = 0$.
- Consider the propagation of sound in a gas.
- For an adiabatic process $-du = dw$ from First law of thermodynamics.
- Internal energy is converted TO work done.
- There is no chemical reaction BUT $\Delta s > 0$ (entropy) when sound propagates!!!!
- Recollect the gas expanding into the vacuum.
- So in a way we can conclude that the propagation of sound makes the gas molecules to interact with the medium space and as a result $\Delta s > 0$.
- In a way we can conclude that sound is the property of space.

Gibbs' Theorem

- The entropy of mixing may be calculated by **Gibbs' Theorem** which states that when two different substances mix, the entropy increase upon mixing is equal to the entropy increase that would occur if the two substances were to expand alone into the mixing volume. (In this sense, then the term "entropy of mixing" is a misnomer, since the entropy increase is not due to any "mixing" effect.) Nevertheless, the two substances must be different for the entropy of mixing to exist. This is the Gibbs paradox which states that if the two substances are identical, there will be no entropy change, yet the slightest detectable difference between the two will yield a considerable entropy change, and this is just the entropy of mixing. In other words, the entropy of mixing is not a continuous function of the degree of difference between the two substances.
- For the mixing of two ideal gases, the entropy of mixing is given by:
- $\Delta S = -nR(x \ln x + y \ln y)$
- where R is the gas constant, n is the total number of moles and x and y are the mole fractions of each of the mixed components.

Sound and Space

- If sound is the property of space why does not sound travel in space?
- Because it should be that space particles are motion less!!