

1 Gravitation: A Challenge to the Second Law of Thermodynamics

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3 **Gases in gravitational fields approximate to an adiabatic temperature gradient. The resulting**
4 **temperature difference can be used to gain mechanical energy. The common explanation to**
5 **establishing the temperature distribution is a heat source located at the mass. The question**
6 **arises, if the heat source is mandatory, or if there are mechanisms, that autonomously add to**
7 **the temperature distribution without external heat source. This article shows that a single**
8 **temperature in gases within a gravitational field is not a stable situation, and that it is possible**
9 **to retrieve mechanical energy from the resulting temperature distribution. Establishing a**
10 **temperature gradient from a single temperature gas in a gravitational field requires heat flow**
11 **from cold to warm, and thus is in direct contradiction the second law of thermodynamics.**
12 **Therefore, the establishing of a temperature distribution that is not just a single temperature**
13 **comprises a counterexample to the second law of thermodynamics and demands review of the**
14 **usage of this law in many scientific areas. Even though just one counterexample is explained,**
15 **research to that topic showed, that similar effects also exist in solid materials and this is not**
16 **just an isolated effect.**

17 A common observation in reality is the temperature distribution in atmospheres, where the atmos-
18 phere typically has a higher temperature close to a planet, and a lower temperature when distant
19 from the planet. At first sight, this does not go well with the second law of thermodynamics. This
20 article discusses the physics behind the process with a simplified thought model.

21 This effort is not supported by a university or other scientific entities. This is just done out of enthu-
22 siastic interest for the topic. The original intention was to gain insights about thermodynamic pro-
23 cesses, however indications for an issue with the second law of thermodynamics became more and
24 more obvious during investigation. For the author, the turning point was to find out, that Ludwig
25 Boltzmann in his „Vorlesungen über Gastheorie“ assumed that the molecules would move on
26 straight lines unless bouncing against other molecules or walls, not considering gravitation for that
27 movement.

28

29 The typical explanation to the temperature distribution in an atmosphere is, that for some reason,
30 heat is generated at the surface of the planet. This could be from processes within the planet, or by
31 means of radiation from outside. While the described processes are reasonable and can be used to
32 explain the mechanics, the question remains, if a temperature distribution would also exist without
33 an external heat source. There is a lot of variables involved in the real processes, and therefore, this
34 article considers a much-simplified model, where no sources of heat, and no radiation are involved.

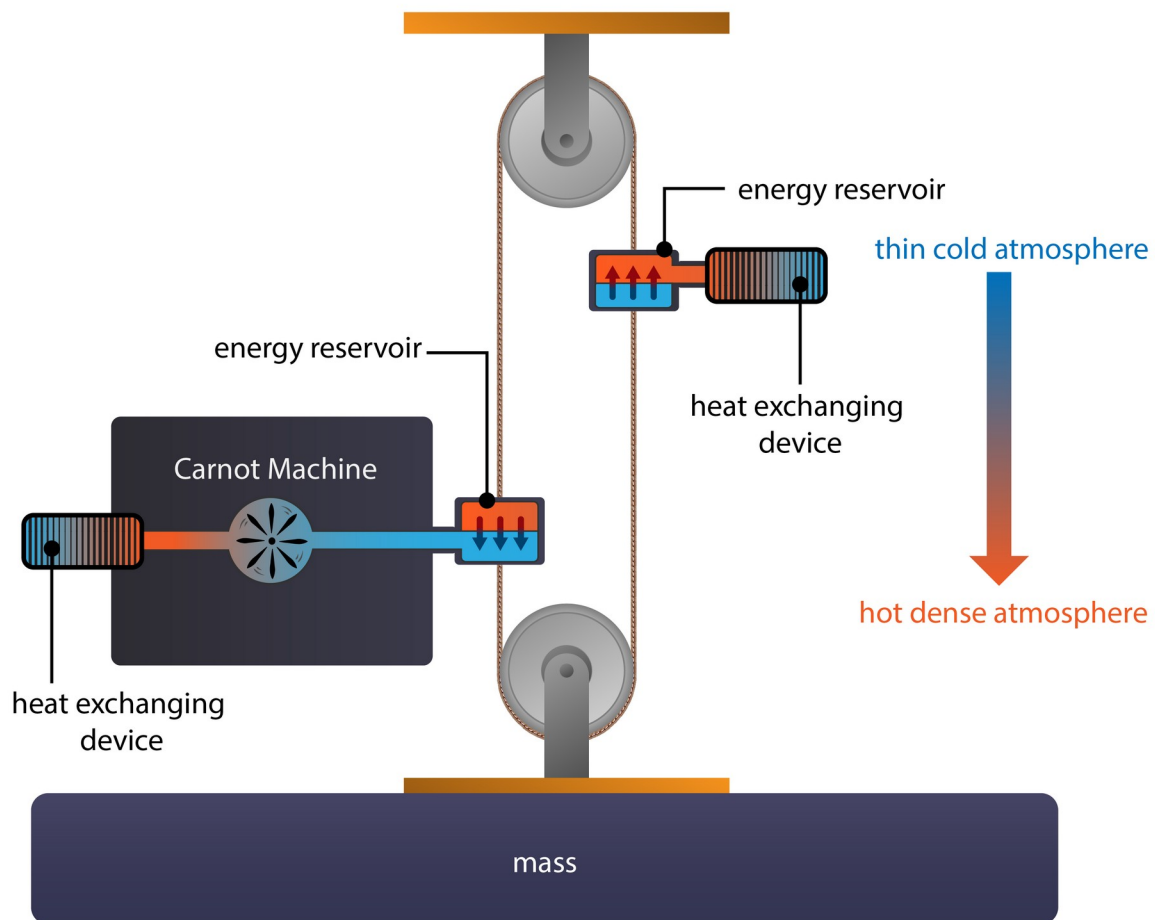
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36 The article targets to examine the following main topics:

- 37 1. Clarify, if mechanical Energy can be retrieved from a temperature distribution even with
38 distant energy reservoirs.
- 39 2. Investigate if a temperature distribution is recovered with gas in a gravitational field without
40 external heat source.

41 Note, that both topics must have at least one credible explanation to create a full model. Since peo-
42 ple have different backgrounds, and also to avoid trivial mistakes, each of the topics is looked at
43 from several perspectives. To falsify this article (in contrast to the attempted proof), all of the
44 perspectives of at least one of the two topics must be proven wrong.

45 1. Retrieving mechanical Energy from a temperature distribution
 46 The first model to retrieve mechanical energy is relatively straight forward. The model to under-
 47 stand most easily is built similar to an Atwood machine as displayed here:



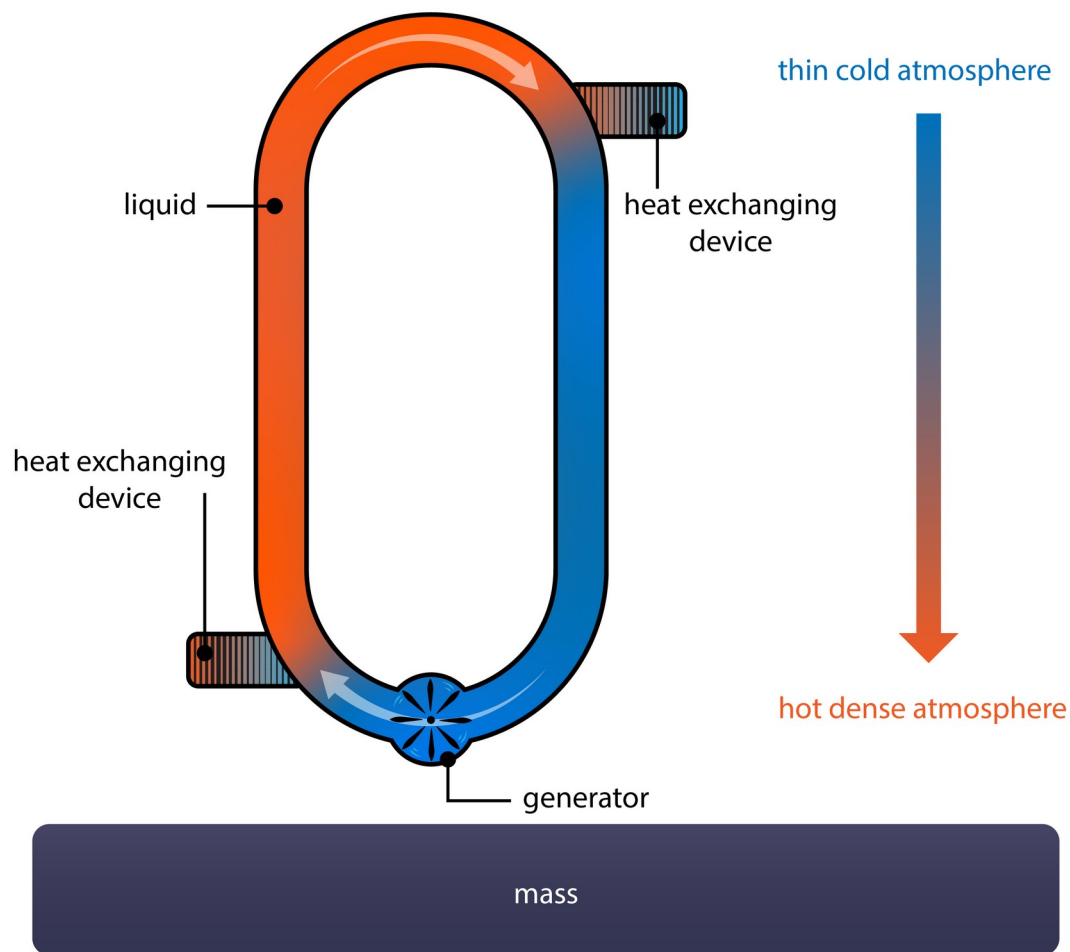
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 49 The machine contains two temperature reservoirs, that alternate between top and bottom. At the top,
 50 the reservoir will cool down to the environment temperature, at the bottom, it will provide the
 51 needed temperature reservoir to work a carnot machine.

52
 53 Since the carnot machine just needs two different temperature reservoirs, it is obvious that the ma-
 54 chine will work until the atmosphere has just a single temperature, assuming that the height of the
 55 machine can be modified in length or is used with different sizes.

56
 57 A second model of a generator of mechanical energy uses a liquid. This is not as straight forward,
 58 but still conclusive:

59
 60 Let's assume a completely isolated loop of a liquid, with just two heat exchanging devices, one at
 61 the bottom of the left side, one at the top of the right side. Lets describe this in a sketch:

62

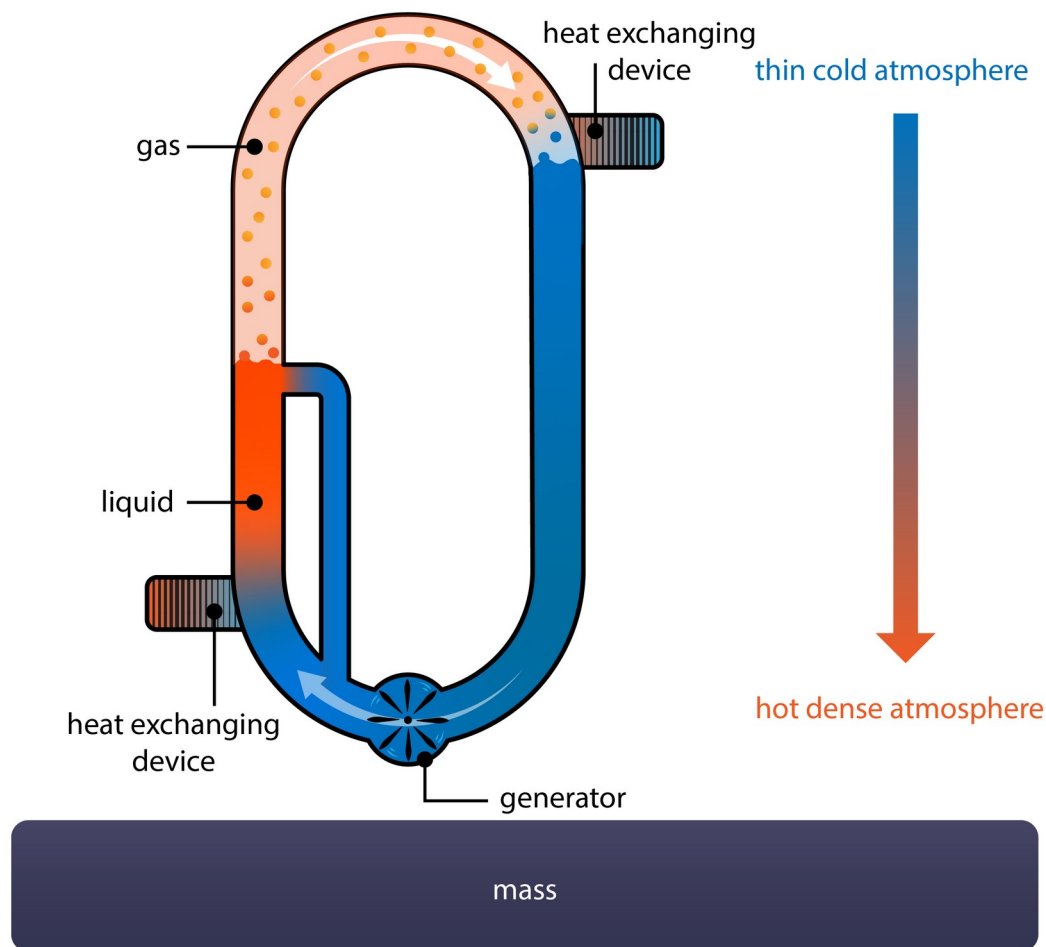


63

64 Let's also assume, that the liquid is fluid at both temperatures, and it behaves like a typical fluid,
 65 means, its density decreases with higher temperature. This means, that the liquid on the left side is
 66 warmer, and has a lower density than the liquid on the right side, which is colder. Therefore, the
 67 fluid will start to move clockwise, and can turn a generator located somewhere within the
 68 loop.

69

70 A variant of this loop would be suitable for increased transport of energy, however it is harder to
 71 understand, and led to more discussions during research. Change the pressure in the loop in a way,
 72 that the dew point of the fluid is reached just above the upper right heat exchanging device. The
 73 goal is to have the material in a gaseous state above the heat exchanging device, so that it can be
 74 condensed at this device.



75

76 Because the fluid on the left hand side has a higher temperature, it will at least partly evaporate, and
 77 therefore the fluid level on the left hand side will sink down with gas above. The inner loop that
 78 directs colder fluid back below the heat exchanging device is needed, because the evaporation heat
 79 cools down the liquid, which then must be reheated. The setup leads to different masses in the two
 80 sides of the loop and different pressure at the bottom. Together with the material transport in form
 81 of gas, the pressure difference can turn a generator.

82 First Result

83 The first result from this experiment is, that the heat distribution of a typical atmosphere contains
 84 exergetic energy. This can be used to gain mechanical energy.

85 Recovery of the Temperature Distribution

86

87 In the second part of this article, the recovery of the temperature distribution is discussed.

88

89 First, let's assume that all energy is readded to the system after it has done some arbitrary work. The
 90 energy should not be stored in mechanical or chemical processes. The conservation of energy is still
 91 considered valid, and to achieve the same temperature distribution as at the beginning, the amount
 92 of energy in the system must stay constant.

94 Macroscopic Observations

95 In real world, all of the planets with atmosphere do have a heat distribution. This is true for all
96 known planets with atmosphere that can be examined. The assumption is, that the temperature dis-
97 tribution in the simplified environment without external heat sources or radiation discussed in this
98 article would follow an adiabatic distribution.

99

100 In an adiabatic pressure and temperature distribution, there will be no exchange of heat, if a gas
101 package rises or sinks to a different level. The gas package itself will cool down if it rises, and it
102 will heat up when it sinks, however the temperature on that new level would just be the temperature
103 that is reached there.

104 Gas with single temperature

105 One of the common assumptions is, that the gas over a mass will cool down to all the same temper-
106 ature if no external heat source is involved. Let's have a closer look at that assumption.

107

108 With an even temperature across all of the volume, what happens when a gas package rises is, that
109 the gas package cools down. However, since the surrounding temperature would be warmer than the
110 package itself, the temperature on the new level would be reduced. The same happens with a gas
111 package sinking to a lower level. When the gas package sinks to a lower level, it heats up. Because
112 it is then warmer than the environment, the surrounding gas is heated up.

113

114 The only way that would allow just a single temperature is, that no material rises or sinks down.
115 This requires, that there must exist layers of pressure that are as thin as just a single molecule. It
116 also means, that the molecules must not move up or down, but just in horizontal direction. This
117 however is not compatible with gases. If there is no movement in vertical direction, a layer above
118 another layer of gas would not have any support from below, and thus fall down. Also, the horizon-
119 tal movement of the molecules would have to be on discrete levels, to avoid that molecules get an
120 impulse in z-direction after a collision.

121 Second Result

122 A single temperature within a gas in a gravitational field is not a stable situation.

123 Microscopic Observations

124 In science, there has been a major discussion about [Maxwell's Demon](#). In that thought experiment, a
125 demon lets pass fast gas molecules through a door between two chambers in one direction, and
126 slower molecules to the opposite direction. This would cause different temperatures in the two
127 chambers, and thus violate the second law of thermodynamics. Science has concluded that the de-
128 mon must generate more entropy by segregating the molecules than it could eliminate.

129 Maxwells Daemon Reloaded: The Puppet Player

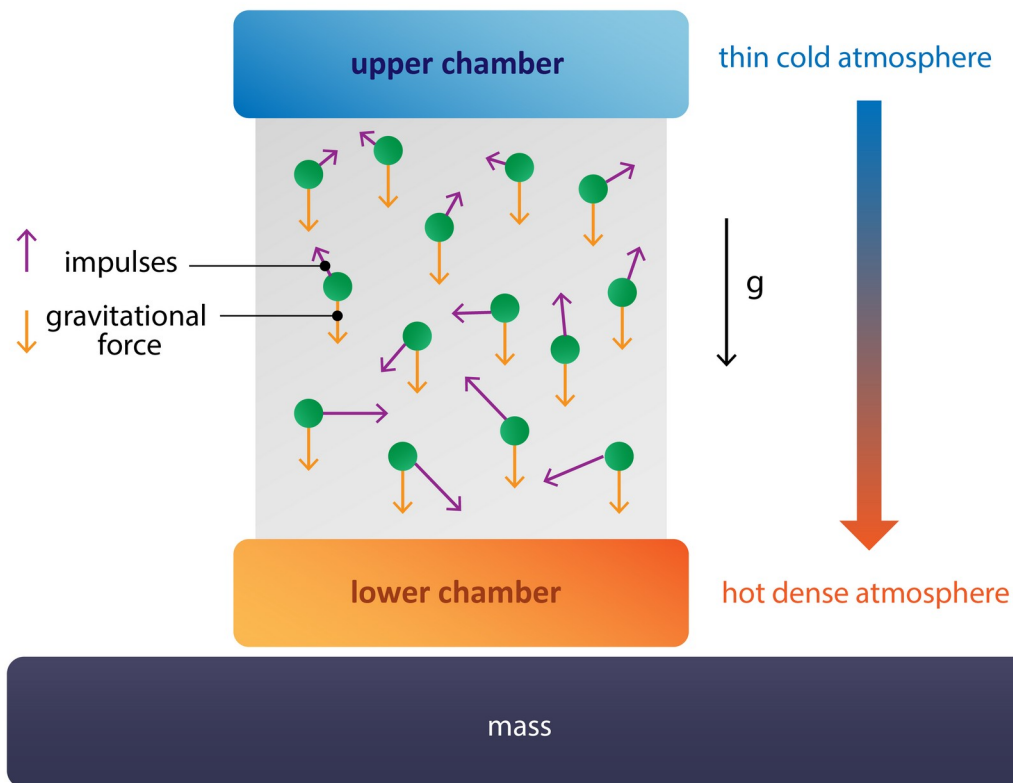
130 Let's add gravitation to the thought experiment, and do some changes to have a similar effect with-
131 out the effort of segregating the molecules.

132

133 Instead of having two chambers next to each other, separated by a door, let's put the chambers
134 above each other, and just connect them with a vertical cuboid. Now, gravitation pulls on each of
135 the molecules from below with a close to constant force. This means, the vertical component of the-
136 <https://youtu.be/DxL2HoqLbyA?t=974>

137 impulse is increased if a molecule sinks down, and it is decreased when the molecule raises. This

138 also means, that the speed, and thus the temperature, of molecules going upward is reduced, while
139 the speed and temperature of molecules sinking down is increased.



141 This leads to two different temperatures in the two different chambers, with the high temperature
142 being close to the mass, and low temperature being distant. In this thought experiment, there is no
143 need to measure the speed of molecules, and thus no additional entropy is generated. This however
144 is a violation of the second law of thermodynamics. Note, that this model also hints at a stable tem-
145 perature distribution even within solid material, even though that is not in the focus of this article.
146 While the adiabatic mechanisms in gases limit the temperature gradient, the gradient in solid mate-
147 rial may be much different.

148 Summary

149 Since we already know, that it is possible to gain mechanical energy from that setup, the complete
150 thermodynamic cycle would look like this:

- 152 1. Wait for a gas in a gravitational field to develop an adiabatic temperature distribution
- 153 2. Gain mechanical energy from that temperature distribution
- 154 3. Readd the energy to the system in form of thermal energy by doing arbitrary work
- 155 4. go to 1

157 The actual contradiction to the second law of thermodynamics is found at the buildup of an adia-
158 batic temperature distribution in a gas if that gas is in a gravitational field. To create this tempera-
159 ture distribution from a single temperature, energy must flow from a colder to a warmer area which
160 would not be allowed with the second law of thermodynamics. While radiation or other physical

161 properties of the real world might have an adverse effect, the mechanism described will still cause a
162 temperature distribution that is not the identical temperature. The consequence to this is, that while
163 the second law of thermodynamics is valid in many circumstances, the requirements to that law will
164 have to be researched, and it is not universally applicable.

166 Competing Interest Declaration: There is no affiliation with any institution. This article has been
167 created purely because of enthusiastic interest in the topic.

168 Coauthors: No other authors than the main author has been writing on this article.