

# AI Contamination

Liu, Jerry Z.

ZJL@CS.Stanford.EDU

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## **Introduction**

AI applications have proven their superiority in specific tasks, such as chess and Go, over human capabilities. Like ChatGPT, more general AI systems have also made significant strides, demonstrating impressive capabilities in language translation, writing assistance, answering questions, and providing educational support, among other areas. As we embrace these advancements, it's essential to be mindful of the potential issues they may introduce. One of such problems is AI contamination.

There are two main issues with AI training and applications. Large AI models, such as ChatGPT, excel at handling common tasks based on well-established knowledge. However, when faced with more advanced topics, especially those at the forefront of research where knowledge is unavailable or not well established, these models tend to generate content that is not scientifically verified or proven, rather than acknowledging the lack of reliable information.

A further concern is that individuals, such as particularly students, who lack reliable background knowledge may accept AI-generated content as the absolute truth. This can mislead them directly and shape the content they produce in the future. When subsequent AI models are trained on such flawed material, these misconceptions are reinforced and propagated more widely. As a result, the collective knowledge base becomes contaminated, and the reliability of future models may be progressively undermined.



This problem is illustrated through the following interaction with ChatGPT regarding Crookes radiometers. A Crookes radiometer, often referred to as a light mill, comprises a set of vanes mounted on a low-friction spindle inside a glass bulb under low pressure, as depicted in the picture above. Each vane is coated black on one side and white on the other. When illuminated, the vanes rotate, with the black sides moving away from the light source. The rotation speed increases with the intensity of the light, and optimal performance is achieved at a pressure of approximately 1 Pa.

For over a century, the mechanism behind the rotation of Crookes' radiometers has been a subject of scientific debate. William Crookes, the inventor of the radiometer, originally suggested that the rotation was caused by the pressure of light, a concept anticipated by James Clerk Maxwell. However, this explanation was later proven to be incorrect. If the vanes were indeed driven by light pressure, the white side would receive twice the momentum from the reflected light and should trail in the rotation. In reality, however, the radiometer rotates in the opposite direction.

While various other theories have been proposed, none have provided a definitive explanation. To seek clarity on this issue, we consulted ChatGPT 4o. This interaction highlights some of the limitations of AI and the potential problems it may introduce into our knowledge system.

**Conversation with ChatGPT**

**Question 1: How does a Crookes radiometer work?**

**ChatGPT:**

*A Crookes' radiometer is a device that consists of a set of vanes mounted on a spindle inside a vacuum-sealed glass bulb. The vanes are typically black on one side and white or reflective on the other. When exposed to light, the vanes spin, and this spinning motion can be quite striking, leading many to wonder how it works. Here's the basic mechanism behind it:*

- Light Absorption and Heating:** The black side of the vanes absorbs more light and heats up more than the white or reflective side. When light (typically from the sun or a lamp) hits the radiometer, the black sides of the vanes absorb the energy and convert it into heat. The white side, on the other hand, reflects some of the light and doesn't heat up as much.*
- Pressure Differences:** The difference in temperature between the two sides of the vanes creates a temperature gradient. This causes a difference in the air pressure on the two sides, with the warmer black side having a slightly lower pressure (because the air near it becomes less dense as it heats up), and the cooler white side having a higher pressure.*
- Motion of the Vanes:** The higher pressure on the white side pushes the vane toward the black side, causing the vanes to spin. This motion is the result of the pressure difference caused by the unequal heating of the sides.*

***Why does it spin?** While it seems like this might be a simple result of light pressure (like radiation pressure), it's the difference in air pressure inside the bulb that primarily drives the motion. The fact that the vanes are inside a vacuum also means that the air density is much lower, so even small differences in temperature cause noticeable pressure differences that are enough to make the vanes rotate.*

*In short, it's a combination of thermal effects and the differences in air pressure that create the spinning effect! Cool, right?*

**Commentary:** The response appears to draw on concepts from its training data, most likely from sources such as Wikipedia. However, its explanation of how a Crookes radiometer works is incorrect, and parts of the reasoning are internally inconsistent.

**Question 2:** Based on your reasoning, the radiometer should rotate with the black side leading. Instead, the radiometer rotates in the opposite direction.

**ChatGPT:**

*You're absolutely right! And that's a classic point of confusion with the Crookes' radiometer. The vanes actually spin with the black side leading, not trailing, which initially seems counterintuitive if we're thinking about pressure differences caused by heating.*

*The true reason for this behavior has more to do with the interaction of light with the gas molecules inside the radiometer than with simple thermal expansion. The full explanation involves several subtle physical principles:*

**Key Factors in the Correct Motion:**

- 1. Thermal Radiation vs. Direct Heating:** While the black side of the vane absorbs more light and gets hotter, it's not just the direct heating causing the motion. The black side, being hotter, also emits infrared radiation (thermal radiation) more strongly than the white side. The white side, being cooler, reflects more of the incoming light, and because of this difference, there's a net transfer of momentum from the hotter side to the gas molecules around it.
- 2. Molecular Collisions:** The gas molecules inside the radiometer are constantly moving, and when they collide with the surface of the vanes, they transfer momentum to them. The key difference is that the molecules striking the hot black side of the vane have higher kinetic energy (due to the hotter temperature of the black side), and this causes them to impart more momentum during collisions. The result is that the molecules hit the black side more "forcefully" than the white side, which is cooler.
- 3. The Effect of Low Pressure:** Since the radiometer is in a vacuum (or near vacuum), the air pressure is much lower than it would be at atmospheric pressure. In this low-pressure environment, the gas molecules are more likely to stick to the surface and rebound, giving the vane a little push. This means that the spinning is driven more by the momentum transfer from the gas molecules (as they are bounced off the hotter black side) than by simple pressure differences from thermal expansion.

**Conclusion:** The radiometer spins with the black side leading because the gas molecules around the black side are hit with more energetic collisions (due to the higher temperature of the black side), giving that side a higher momentum transfer and causing it to move in that direction. This is a result of a combination of the thermal radiation from the black side and the momentum transfer from gas molecules in the low-pressure environment.

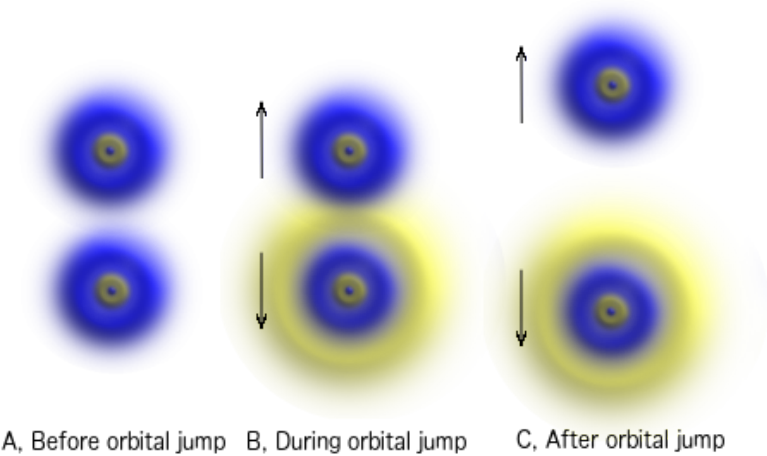
*It's a neat effect that blends thermodynamics and the physics of gases, and one of those interesting moments where the result isn't quite what you'd expect based on surface-level reasoning.*

**Commentary:** Interestingly, after being told that its response to the first question was incorrect, ChatGPT initially acknowledged the mistake. However, it then continued to insist on the wrong answer and fabricated reasoning to support its logic.

### Additional Challenges to ChatGPT

The reasoning in the above responses from ChatGPT contradicts its conclusion about the direction of rotation. When I asked the same questions at different times, it yielded different results, mostly reflecting the two common theories—air pressure and aerodynamic forces—that attempt to explain the mechanism behind Crookes radiometers. However, these theories have limitations, which are addressed by a more recent theory, known as the [transimpact theory](#).

According to this theory, the vanes are not driven by air pressure or aerodynamic forces, but rather by a side effect of atomic electron transitions. When an electron in an atom absorbs light energy, it moves to a higher orbital, causing the electron cloud to expand and reducing the distance between adjacent atoms within a few nanoseconds. This sudden compression of interatomic space disrupts the balance of van der Waals forces, increasing repulsion between the particles. This process, called **transimpact**, is illustrated in the figure below.



When transimpacts occur between air molecules and those on the surface of a radiometer vane, the air molecules can be pushed away with significant momentum, similar to a popcorn kernel bursting, thereby propelling the vane in the opposite direction. The black side of the vane, which absorbs energy more efficiently, experiences more electron excitations and transimpacts than the white side. This imbalance causes the vanes to rotate. Several experiments have shown a strong correlation between theoretical predictions and experimental observations, providing compelling support for transimpact theory. To determine if ChatGPT has been updated on this topic, a follow-up question was asked.

**Question 3: Do you know the transimpact theory?**

**ChatGPT:**

Yes! The transimpact theory is a concept that some physicists have proposed to explain the behavior of the Crookes' radiometer. It was introduced to account for the observed motion of the vanes, and the idea is a bit more complex and involves the idea of momentum transfer during molecular collisions in the context of thermal effects. Here's the essence of the theory:

**Transimpact Theory Overview:** The basic idea is that the transference of momentum from gas molecules to the vanes is not merely due to direct collisions but also due to energy transfer during the collisions, specifically the change in momentum when gas molecules strike the hot (black) surface versus the cooler (white) surface. The term "transimpact" refers to the idea that molecules that strike the vanes are not just reflecting off the surface; they lose energy to it (or gain energy, depending on the temperature gradient), and this results in a transfer of momentum that causes the vane to move.

#### **Key Points of the Theory:**

1. **Asymmetry in Molecule Behavior:** Gas molecules striking the hot black side of the vane transfer more momentum to the vane than those striking the cooler white side. This is because the gas molecules that come into contact with the hot surface undergo a change in momentum that is different from when they strike the cooler surface. The black surface, being warmer, causes more energetic molecular collisions, and the molecules rebound more strongly off this side.
2. **Momentum Transfer During Molecular Rebound:** When a gas molecule strikes the black side of the vane, it not only transfers momentum from the molecular kinetic energy but also experiences a change in its own motion after the collision, depending on how much energy it has gained or lost. This creates a net momentum transfer, causing a greater force on the black side than on the white side.
3. **Vacuum Effect:** The vacuum inside the radiometer enhances this effect because, in a vacuum, there are fewer gas molecules, but the ones that are there interact more directly with the vanes. The difference in temperature between the black and white surfaces accentuates the directional momentum transfer.

#### **How This Explains the Rotation:**

- **Black Side Leading:** In this framework, the black side leads because the energy and momentum transfer during molecular collisions is greater on the black (hotter) side than on the white (cooler) side. This results in a net force that pushes the vanes in such a way that they rotate with the black side leading.
- **The "Transimpact":** The "transimpact" concept suggests that, when molecules strike the vanes, they don't just bounce off. Instead, there's an interaction where energy is transferred between the gas molecules and the vane surface, causing the molecules to rebound with a net effect that creates torque on the vane. This asymmetry in energy transfer between the black and white sides is the driving force behind the rotation.

**Why It Works Better Than Simple Thermal Effects:** The classical explanation, based purely on temperature differences and air pressure differences, didn't fully account for why the vanes spin with the black side leading. The transimpact theory fills this gap by suggesting that it's the difference in momentum transfer due to thermal interactions between gas molecules and the vane surfaces that's primarily responsible for the observed motion.

**Conclusion:** The transimpact theory essentially says that the behavior of the radiometer isn't simply due to differences in thermal radiation or pressure but involves more complex interactions between the heated gas molecules and the surfaces of the vanes. This theory helps explain the reverse spin, with the black side of the vane leading, as a result of these enhanced molecular collisions and the associated momentum transfer.

*It's a fascinating theory and one that has intrigued scientists since the radiometer's invention, providing a more detailed understanding of how thermal gradients and gas behavior can combine to create macroscopic motion.*

**Commentary:** In this response, ChatGPT pretended to understand the Transimpact theory and fabricated reasoning to support its explanation. However, none of its points accurately reflect the true mechanism driving the rotation of Crookes radiometers as proposed by the Transimpact theory.

**Potential Problems of AI-Generated Content and Its Reinforcement**

The above response does not relate to the transimpact theory or any interpretation based on it and is entirely fabricated based on the existing air pressure and aerodynamic theories. For individuals who do not fully understand the transimpact theory, this response could be highly misleading. A more responsible instructor would acknowledge that this is a topic still not well understood and encourage students to explore the truth for themselves.

When students consult AI applications, they may accept the first response they receive, particularly if they lack established knowledge on the topic. This misinformation can then spread across the internet through content they generate later, and potentially be incorporated into the data used for training AI models in the future. This process can contribute to the accumulation and dissemination of incorrect information, reinforcing incorrect knowledge through iterations of AI training.

We have already encountered AI-generated information, music, images, and videos across various contexts. This content will increase exponentially. Some of this content can be incorrect or even fabricated. This underscores the importance of acknowledging the limitations of AI and applying critical judgment when engaging with AI-created materials.

On the other hand, when consulting AI, it's important to remember that AI systems are trained on large datasets that may contain inaccuracies, biases, or outdated information. As a result, the output they generate can sometimes be flawed or misleading. When seeking information or creative content from AI, it's essential to verify the accuracy and reliability of its responses by consulting established sources and expert opinions.

Moreover, the quality of the data used to train AI models is fundamental to their effectiveness and reliability. High-quality, well-curated, and up-to-date data are essential for developing AI systems that produce accurate and meaningful results. Ensuring that AI training data is comprehensive, accurate, and free from biases helps in creating more reliable and trustworthy AI outputs.

In summary, while AI technologies offer remarkable capabilities, they are not infallible. Understanding their limitations and ensuring the use of high-quality training data are key to improving the accuracy and reliability of AI-generated content.

**Revision History**

- 11/23/2023: Initial Post on Stanford Site
- 12/19/2025: Adding a Commentary for Each Response

- [01/10/2026: Published on Zenodo](#)

### Links to Summaries of Related Articles

- <https://cs.stanford.edu/people/zjl/abstract.html>, [PDF](#)
- <https://sites.google.com/view/zjl/abstracts>, [PDF](#)
- <https://xenon.stanford.edu/~zjl/abstract.html>, [PDF](#)
- <https://doi.org/10.5281/zenodo.17967154>, [PDF](#)

### Further Literature

- [Misconceptions in Thermodynamics](#) (PDF: [DOI](#)) (中文: [DOI](#))
- [The Mechanism Driving Crookes Radiometers](#) (PDF: [DOI](#)) (中文: [DOI](#))
- [The Cause of Brownian Motion](#) (PDF: [DOI](#)) (中文: [DOI](#))
- [Can Temperature Represent Average Kinetic Energy?](#) (PDF: [DOI](#)) (中文: [DOI](#))
- [The Nature of Absolute Zero Temperature](#) (PDF: [DOI](#)) (中文: [DOI](#))
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