An error in ``A photon thermal diode", 2014.

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The paper "A photon thermal diode", (5:5446, 2014), claims that it presents *"… the first experimental results for a photon thermal diode*", that promises significant benefits for thermal engineering and society, such as *"thermal regulations of building envelopes, … spacecraft thermal shielding, …thermal information processing",* etc. However, this claim is based on a fundamental error in the design and interpretation of the experiments, which cannot and do not demonstrate that the proposed device constitutes a thermal diode.

A thermal diode is a two-terminal device whose heat transfer coefficient depends on the direction of the heat flux. This property can be characterized by the inequality $Q(T_1, T_2) \neq -Q(T_2, T_1)$, if $T_1 \neq T_2$, where $Q(T_A, T_B)$ is the heat flux between the terminals A and B with the temperatures T_A and T_B. This phenomenon is called thermal rectification.

The essential components of the diode proposed in the paper are the collimator and the test section aligned along the axis of heat transfer, as shown in the top of Fig. 1. The collimator is made from a perforated block of absorbing material with holes, parallel to the axis. The test section includes an array of pyramid mirrors with tips oriented in the axial direction. The collimator and the test section are placed between a hot black body cavity and the cooler side maintained at the constant temperature T_∞ as shown in Fig. 1. The black body is heated to a certain level $T_{BBC} > T_\infty$, and, after the system is stabilized, the heater is shut down, allowing the black body to cool because of thermal radiation through the collimator and the test section. The rate of change of T_{BBC} is recorded and is used to recover the heat flux through the system.

In order to demonstrate that the collimator and the test section together constitute a thermal diode it is necessary to turn this composite device around and measure the heat flux in the structure from the bottom of Fig. 1. If the pair, collimator-test section, makes the thermal diode then the cooling curves of the structures ≡⊲ and ⊳≡ must be different.

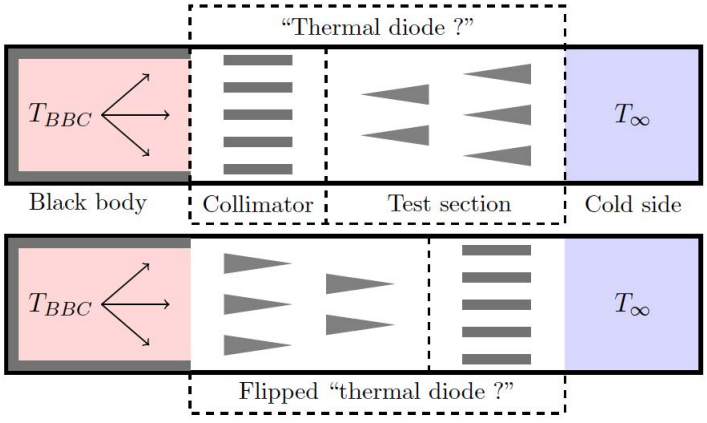

Figure 1. The structure of proposed "thermal diode" in the direct and reversed positions

However, instead of considering the structure obtained by turning around the entire proposed diode, the paper [1] considers another structure, which is obtained from the "diode" shown in Fig. 1 by *"flipping the test section",* as shown in Fig.2. Since the device in Fig. 2 is obtained by a change of the internal structure of the proposed "diode" the difference in heat fluxes in the structures from Figs. 1, 2 does not represent thermal rectification, but merely confirms that different structures normally have different rates of heat transfer.

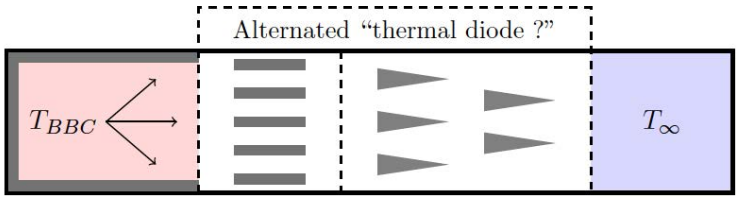

Figure 2. The alternated "thermal diode" considered in the paper

The above shows that despite an unambiguous claim that the paper [1] presents a photon thermal diode, the reported experiments do not present a thermal diode of any kind.

References:

1. Chen, Zh., *et al.* A photon thermal diode, *Nature Communications* **5**: 5446 (2014)