A chirality switching device designed with transformation optics

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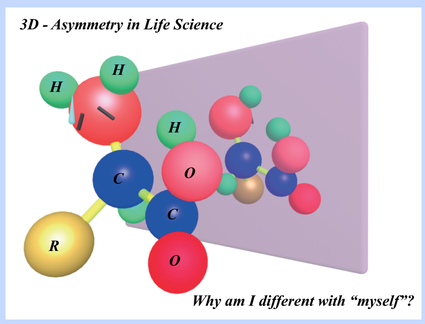
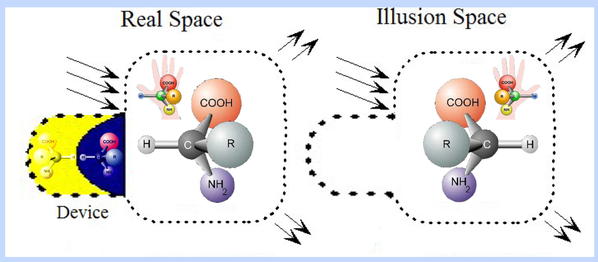
1. Background



2. How to transfer chirality

2.1 Existent solution — Illusion Optics

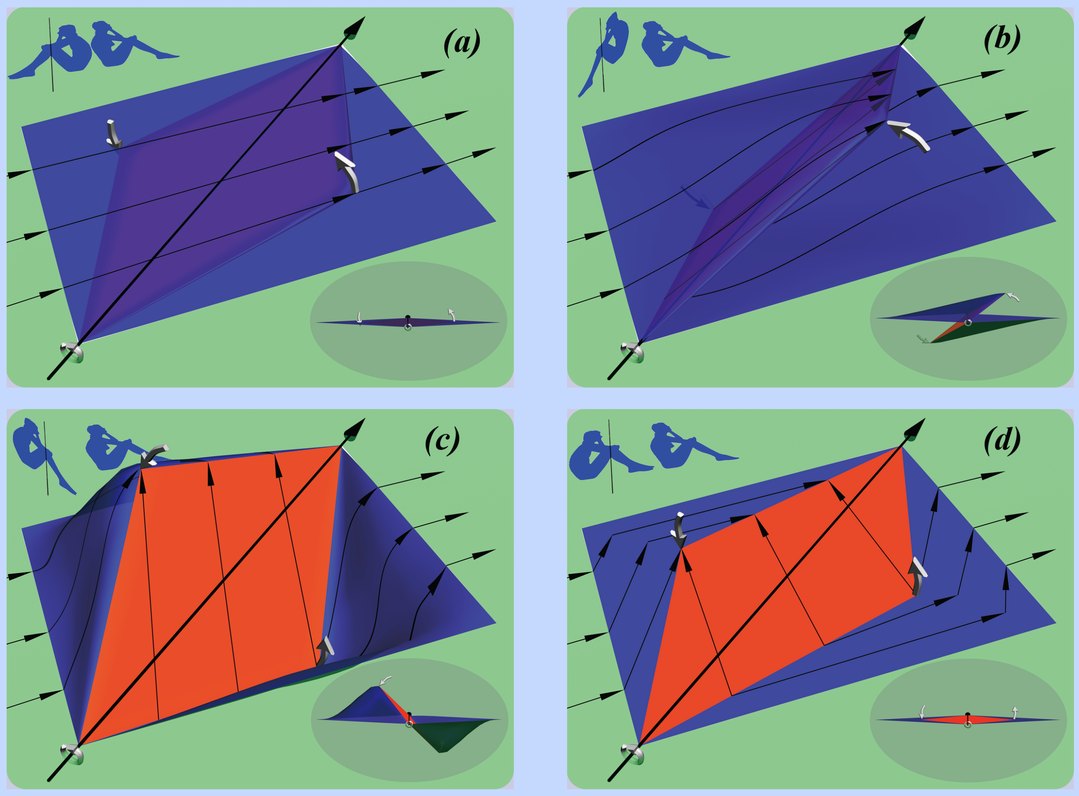


This idea is very good, but there still exist minor defects: it is object dependent and the objects are desired to be transparent if the corresponding illusions are to be achieved effectively.

Motivations: Design a general

- **Transformation Mirror for 2-dim. case;**
- **Chirality Switching Device for 3-dim. case.**

2.2 Our solution



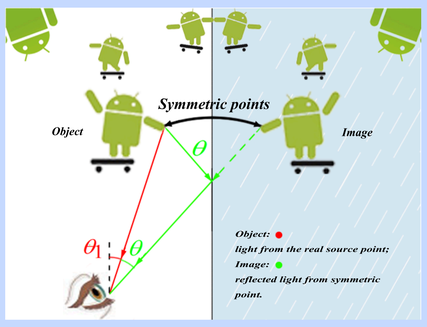
The operation of flipping space generates a transformation optical device which flips the light rays[1] — *mirror effect?*

2.3 Mathematic Details

Region I,II	$\frac{1}{2}a \le -x \pm \frac{1}{2}y \le a$	$\mu = 3x + 2a - 2\lvert y\rvert$ $\nu = y$ $\omega = z$	$\overleftrightarrow{\epsilon}_r = \overleftrightarrow{\mu}_r = \frac{1}{3}\begin{pmatrix} 5 & \pm 6 & 0 \\ \pm 6 & 9 & 0 \\ 0 & 0 & 9 \end{pmatrix}$
Region III,IV	$\frac{1}{2}a \le x \pm \frac{1}{2}y \le a$	$\mu = 3x - 2a + 2\lvert y\rvert$ $\nu = y$ $\omega = z$	$\overleftrightarrow{\epsilon}_r = \overleftrightarrow{\mu}_r = \frac{1}{3}\begin{pmatrix} 5 & \mp 6 & 0 \\ \mp 6 & 9 & 0 \\ 0 & 0 & 9 \end{pmatrix}$
Region V	$\lvert x\rvert + \frac{1}{2}\lvert y\rvert \le \frac{1}{2}a$	$\mu = -x$ $\nu = y$ $\omega = z$	$\overleftrightarrow{\epsilon}_r = \overleftrightarrow{\mu}_r = \begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$

3. Numerical Confirmation of Mirror Effect

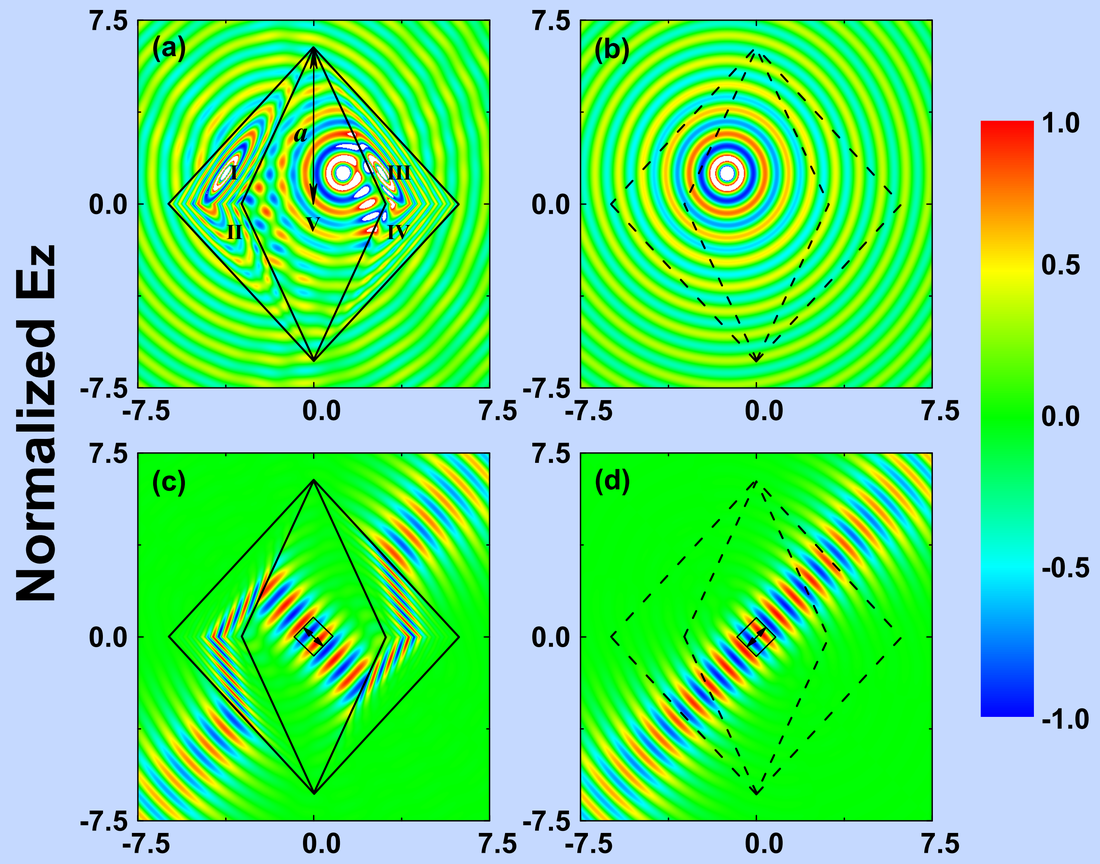
3.1 What makes a mirror image



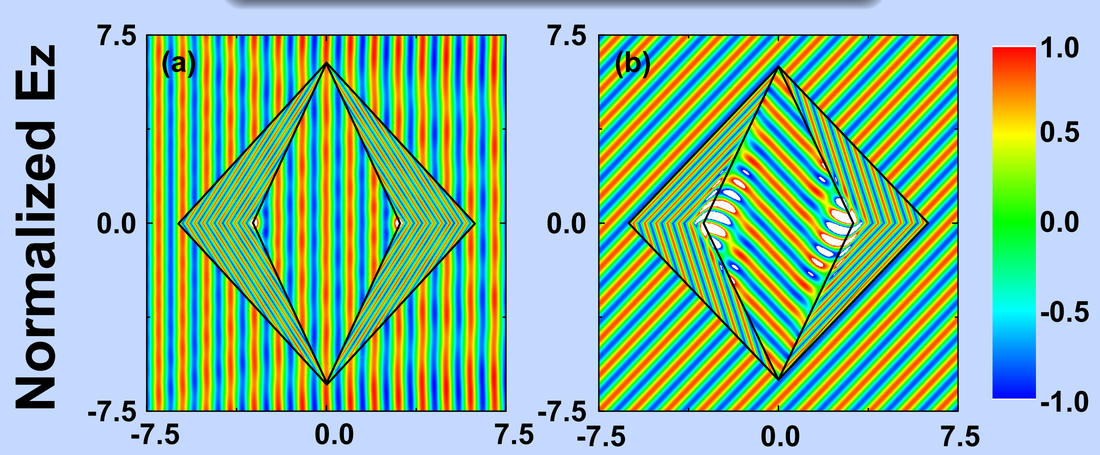
The criterions of substituting someone with his mirror image:

- **Transforing light source to its symmetric point;**
- **Replacing incident rays with reflected rays.**

3.2 2-dim. case — Transformation Mirror



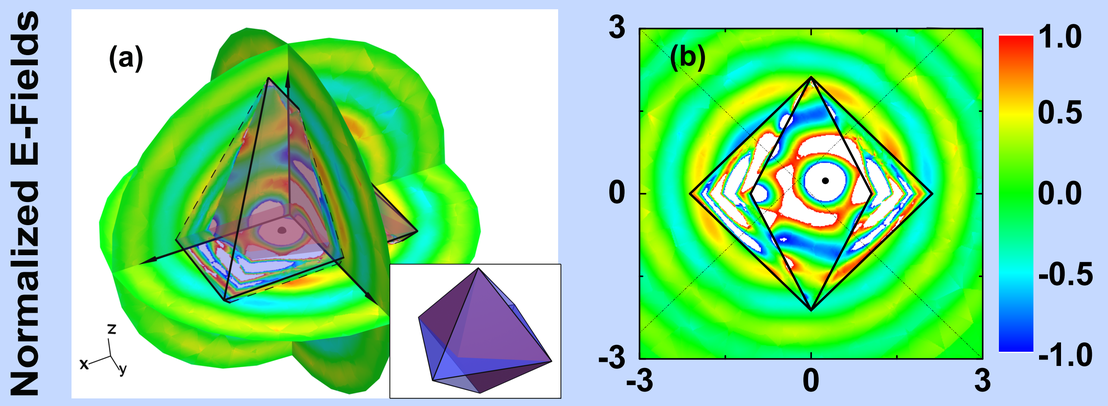
- **Fig.(a,b): Source to symmetric point;**
- **Fig.(c,d): Light rays reflected.**



Device undetectable!

3.3 3-dim. case — Chirality Switching Device

Shrink along z-axis can extend 2-dim. device to 3-dim.[2]



4. Conclusions

- The design of transformation mirror is testified to be capable of reflecting point and light rays while hiding itself from the observer;
- The chirality switching device poses the possibility of transfering handedness by introducing a mirror plane into 3-dim. space.

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References

[1] U. Leonhardt, Science **312**, 1777 (2006); J. B. Pendry, and *et. al.*, ibid. **312**, 1780 (2006).

[2] M. Rahm, and *et. al.*, Phys. Rev. Lett. **100**, 063903 (2008); L. Bergamin, Phys. Rev. A **78**, 043825 (2008); W. Yan, M. Yan and M. Qiu, arXiv [physics.optics]: 0806.3231 (2008).