

Optical cloaking

Matteo Ciardi

University of Florence

iLight: Light sciences meet optical illusions

24 may 2022

Optical cloaking

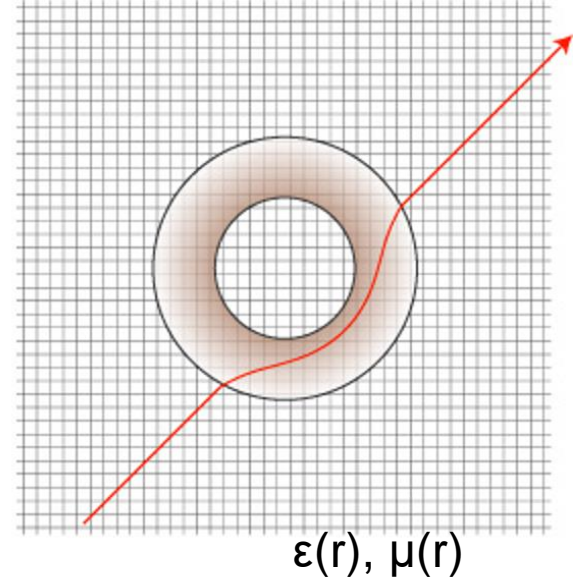
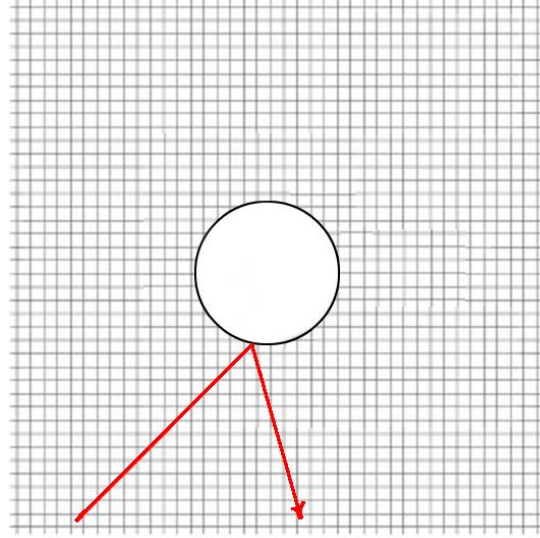
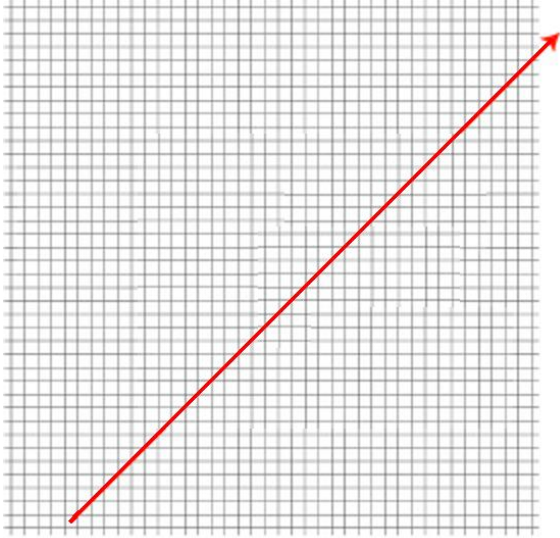


Matteo Ciardi

University of Florence

iLight: Light sciences meet optical illusions

24 may 2022



Perfect cloaking:

- All directions
- All frequencies (colors)
- All polarizations

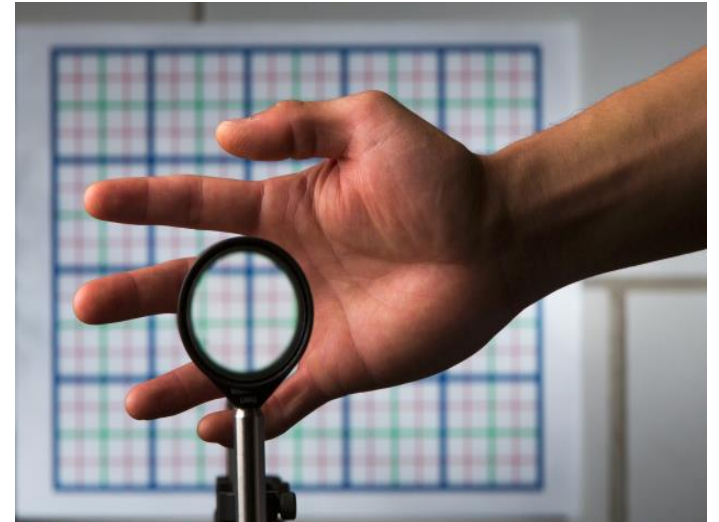
Very difficult to do in practice!

Metamaterials

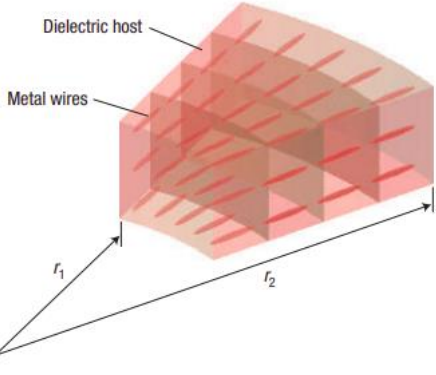
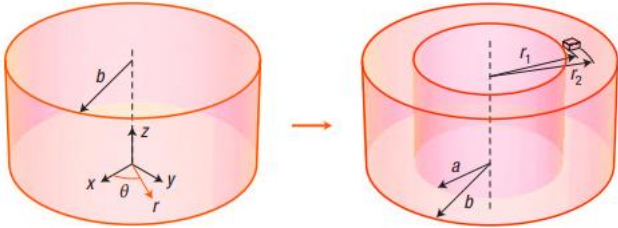


VS

Geometrical optics



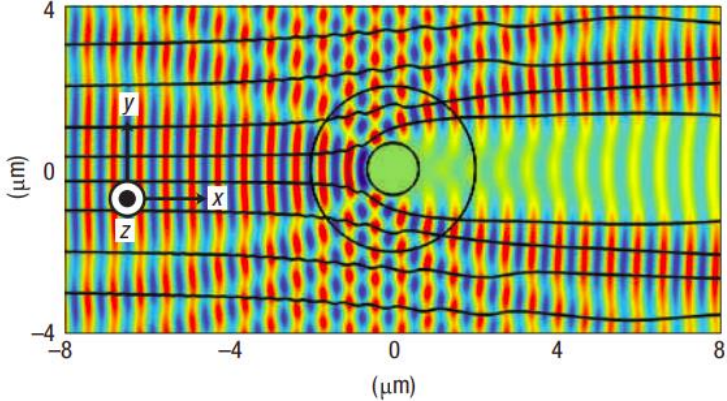
Metamaterials: cylindrical cloak



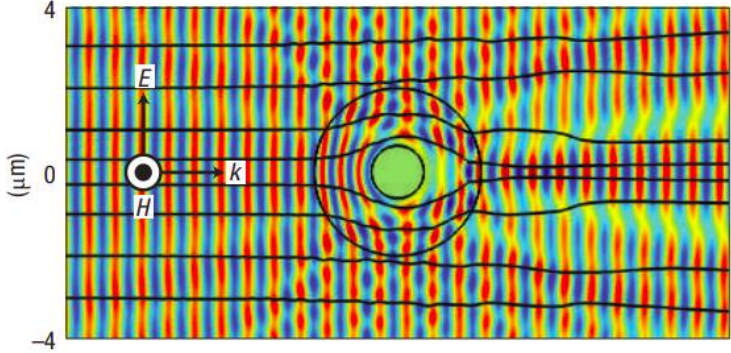
632.8 nm

Cai et al, Nat. Photonics 1, 224–227 (2007).

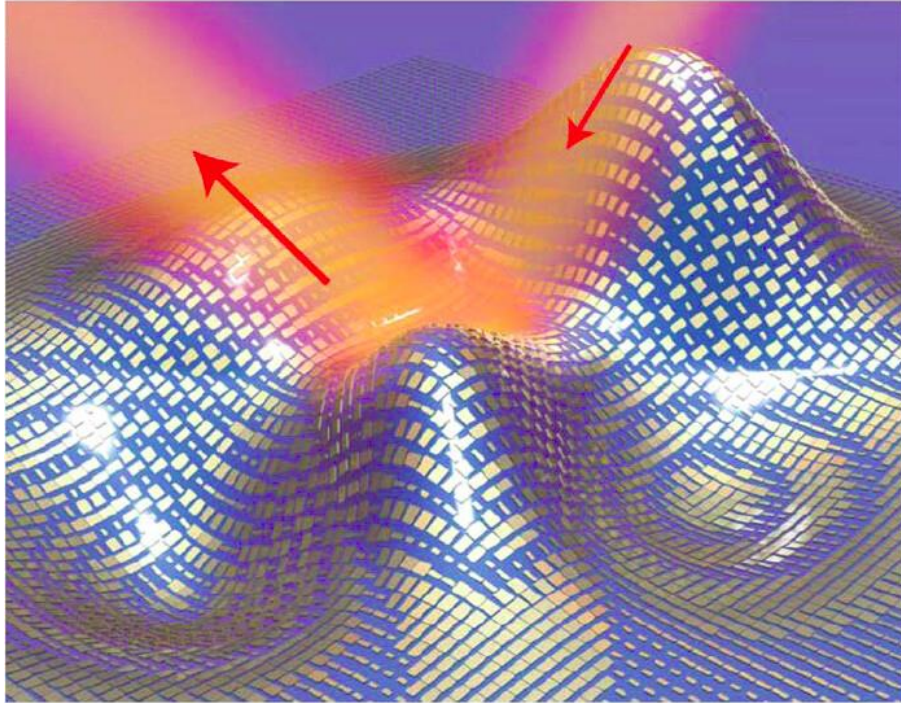
Cloak off...



Cloak on!

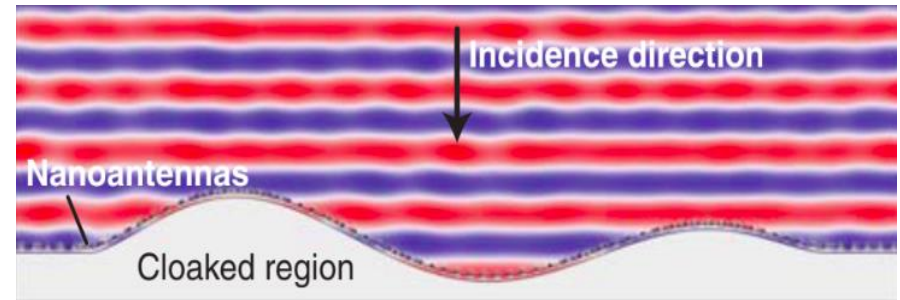
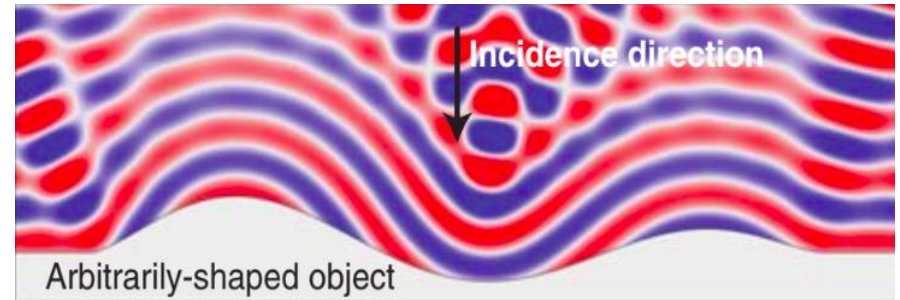
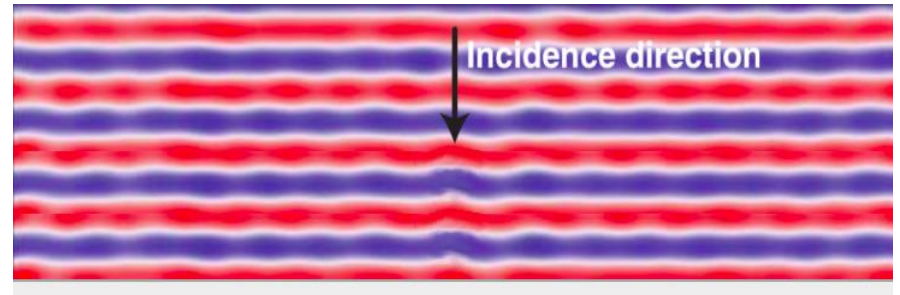


Metamaterials: Metasurface carpet cloak



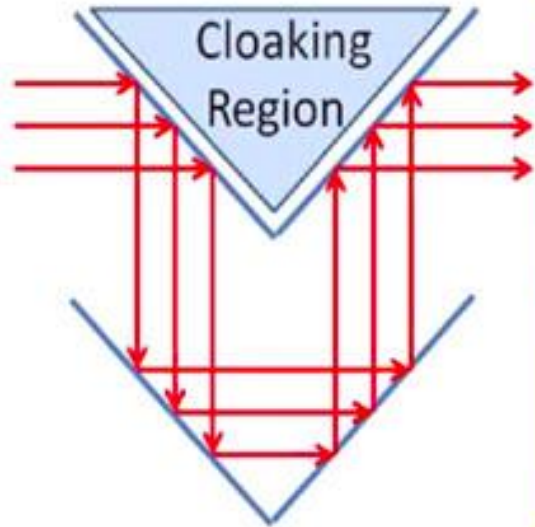
~730 nm

Ni et al., Science 349, 1310 (2015)



Geometrical optics: Mirror-based cloaking

(a)



(b)

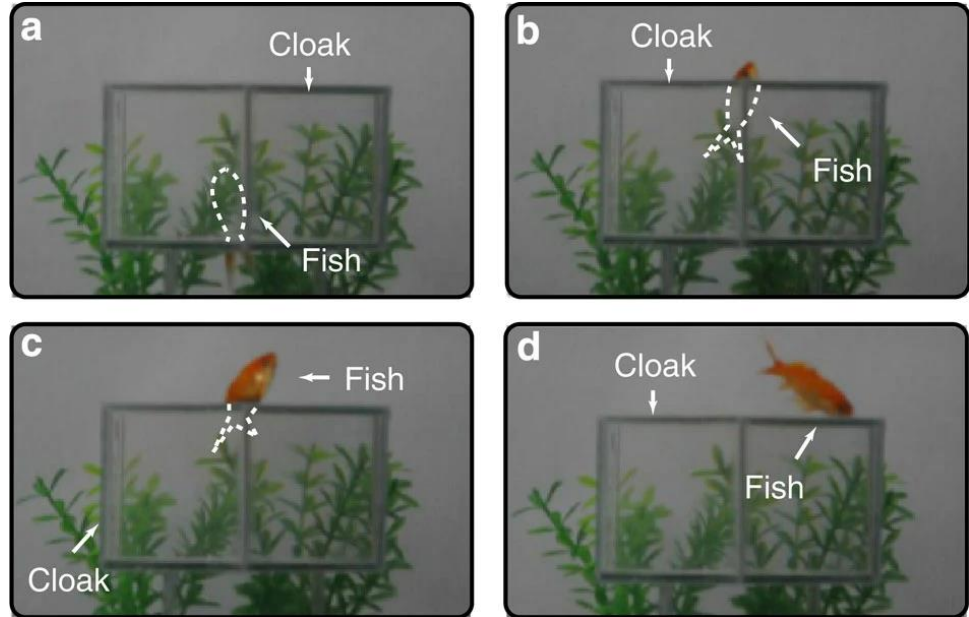
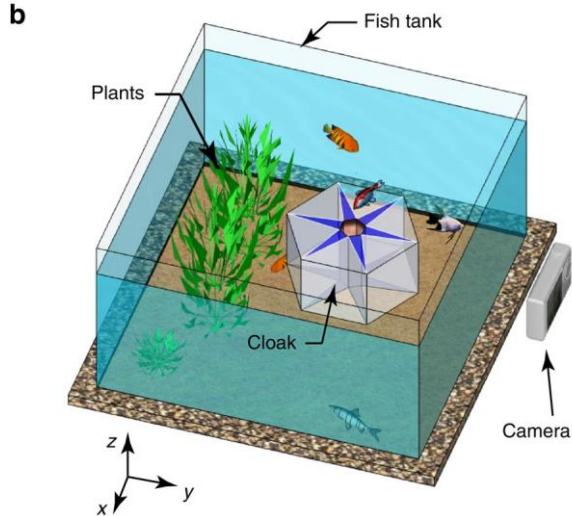
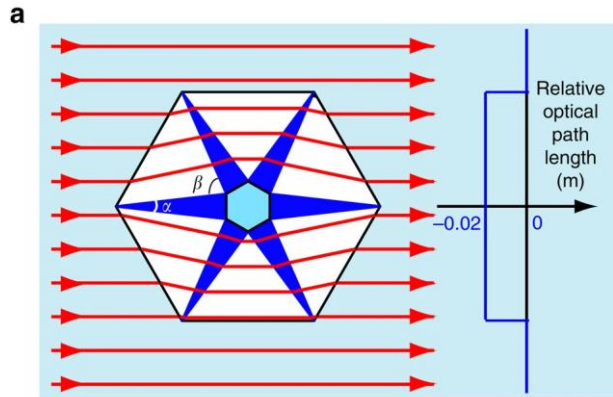


(c)



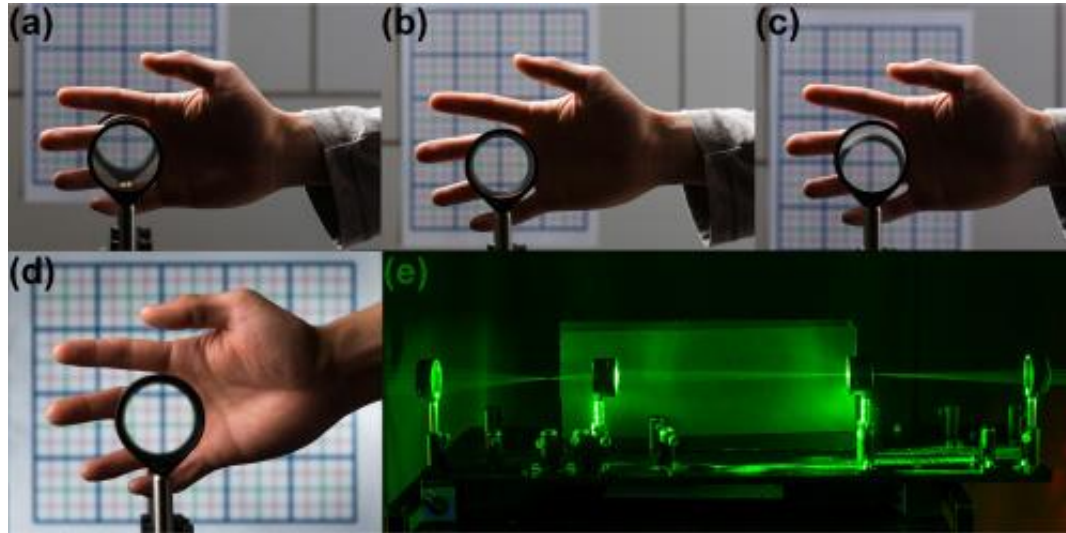
Howell et al., Appl. Optics 53, 1958 (2014)

Geometrical optics: Refraction-based cloaking

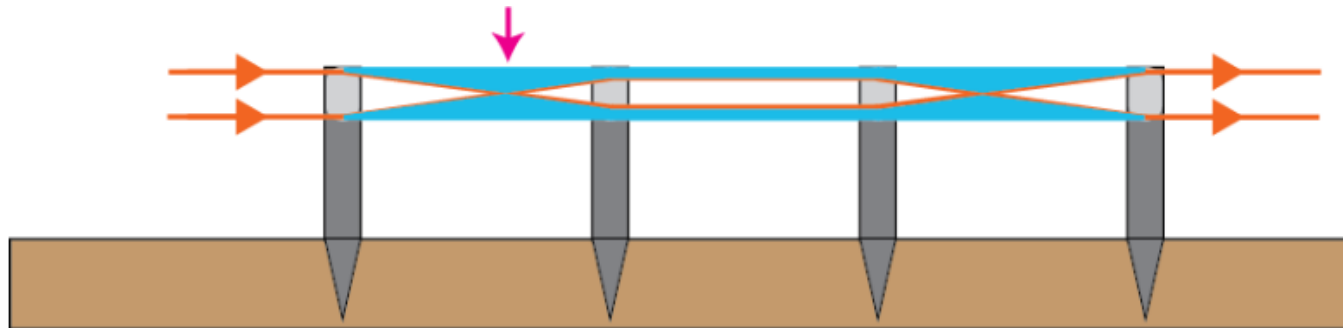


Chen et al., Nat. Commun. 4, 2652 (2013)

Geometrical optics: Lens-based cloaking



Choi and Howell, Opt. Express 22, 29465 (2014)



Metamaterials...

Controlling light flow at a microscopic level

Can work in multiple directions

Very small objects (only proof of concept un

Expensive

Limited bandwidth

Geometrical optics...

Works over a wide range of frequencies

Scalable

Relatively cheap (in principle)

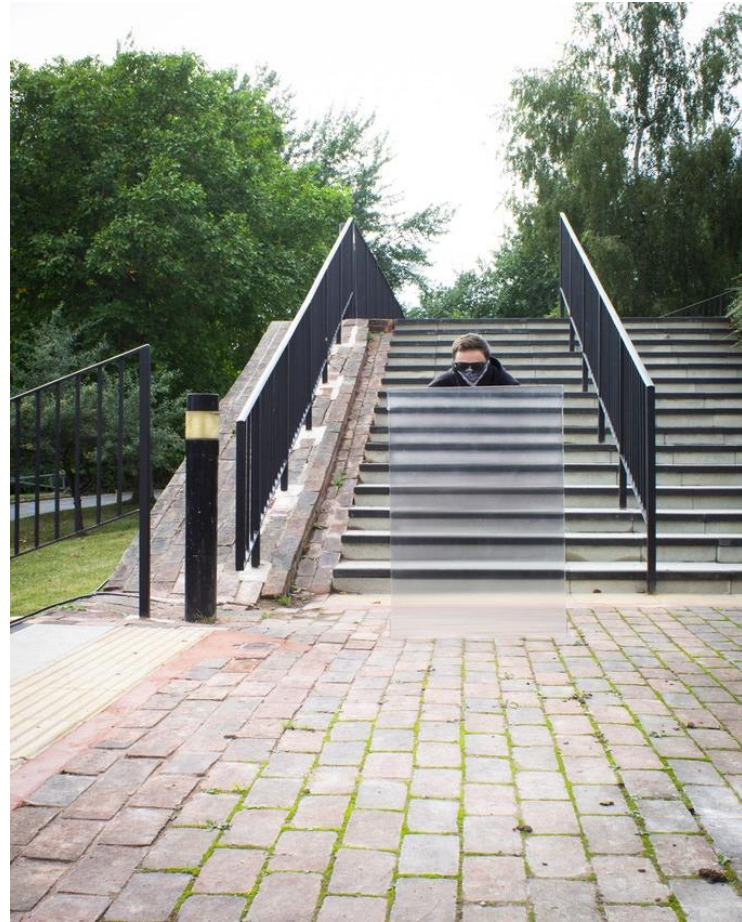
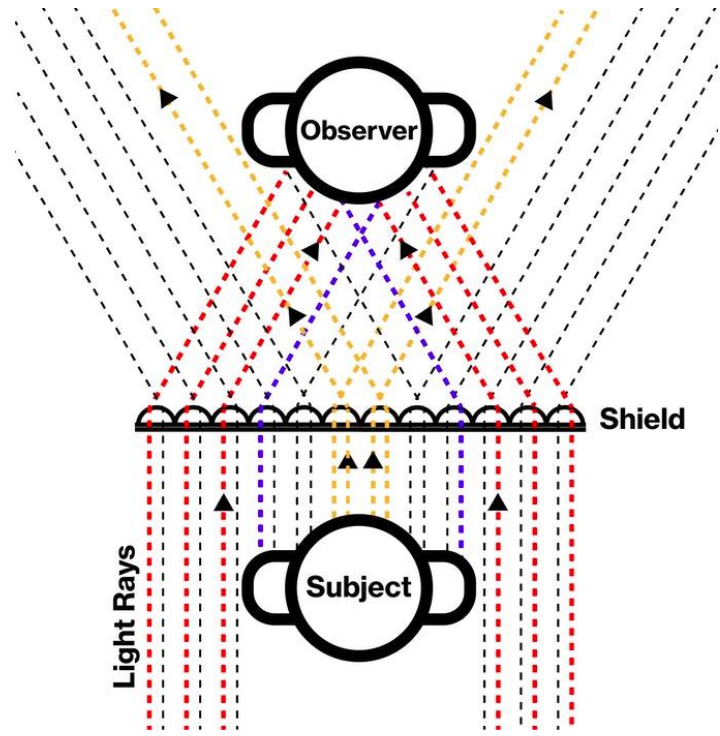
Bulky structures

Limited directionality

What about this...?



Lenticular screens



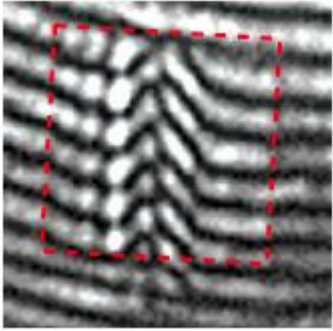
A different approach: **Adaptive camouflage**



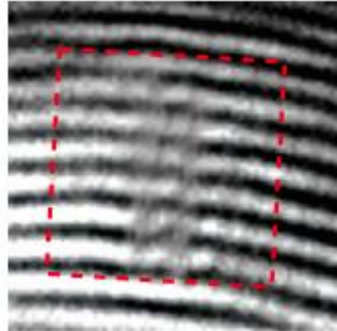
Thank you for your attention...

...and I will see you around!

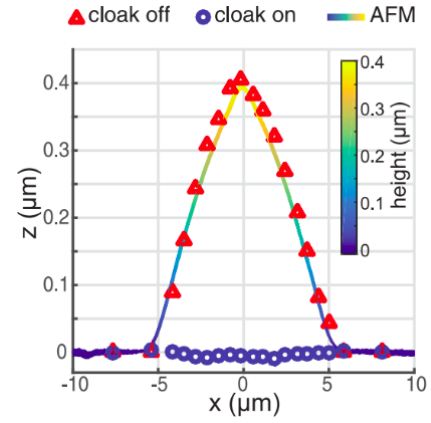
(...or not)



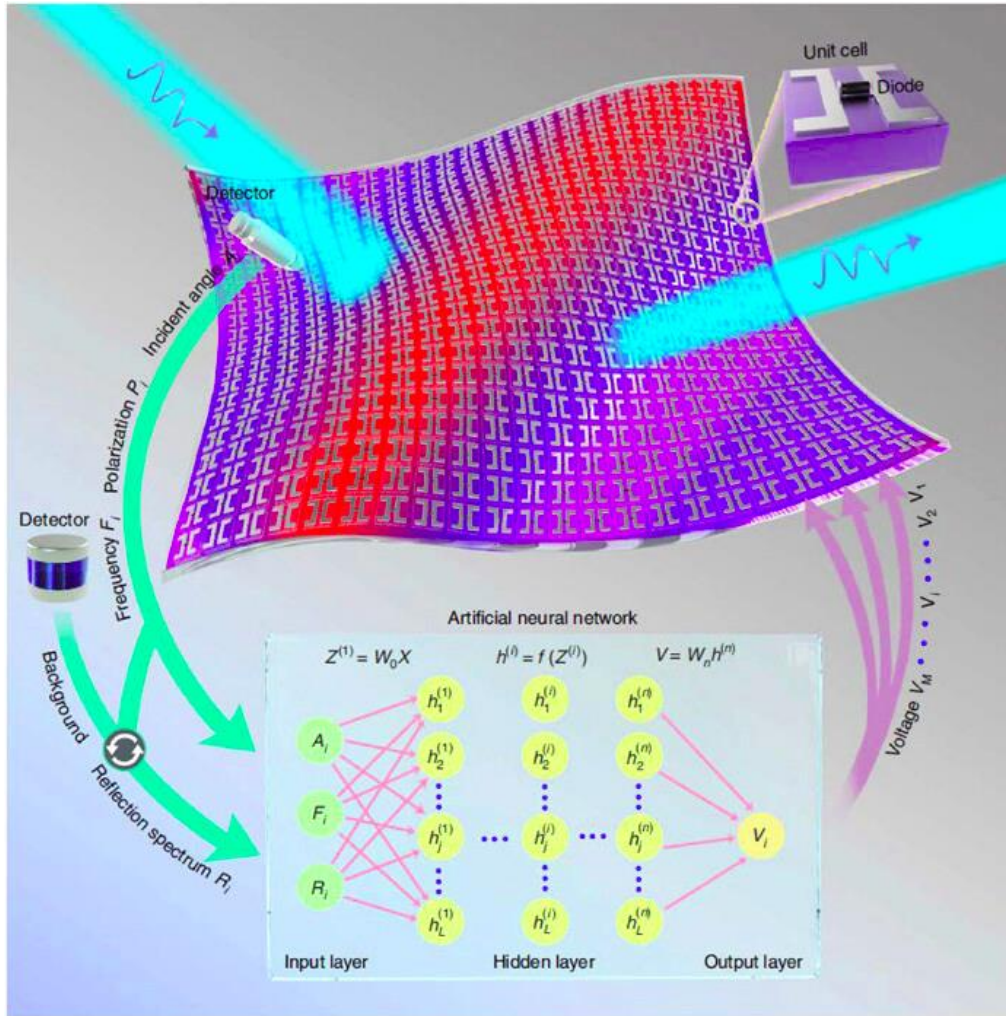
Cloak off...



Cloak on!



Gold blocks (nanoantennas)



Qian et al., Nat. Photonics 14, 383 (2020)

Reconfigurable carpet cloak
(microwave range)

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}_{\text{perfect cloak}} = \begin{bmatrix} 1 & L/n \\ 0 & 1 \end{bmatrix}$$

