

Title: Physics in Nature Presentation: Mirages

Date: Aug 19, 2011 03:30 PM

URL: <http://pirsa.org/11080118>

Abstract:

# Outline

Mirages

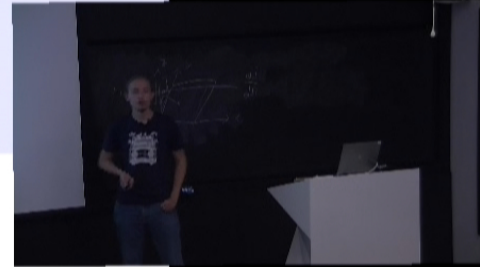
Robert L.  
Schuhmann

The  
Phenomenon

Physics in it

Astrophysics  
around it

- 1 The Phenomenon: What? Where? When?
- 2 Physics in it
- 3 (Astrophysics around it)



# In the Desert

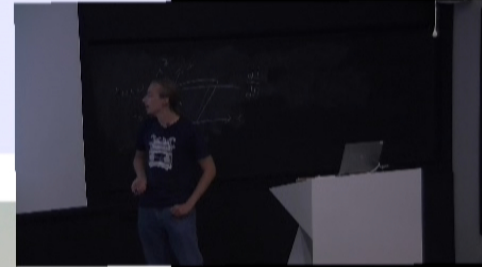
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# On the Open Sea

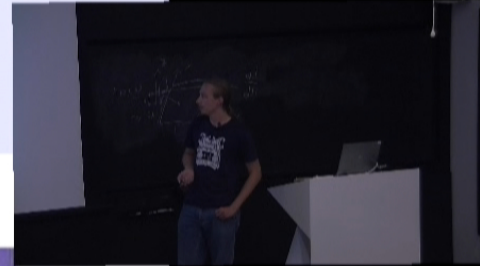
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# On the Open Sea

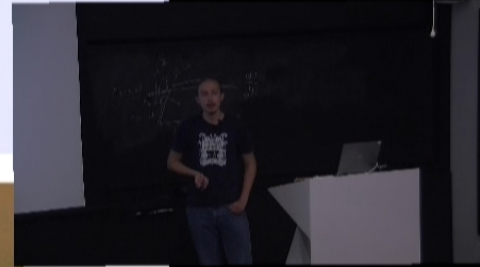
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# UW Parking Lot

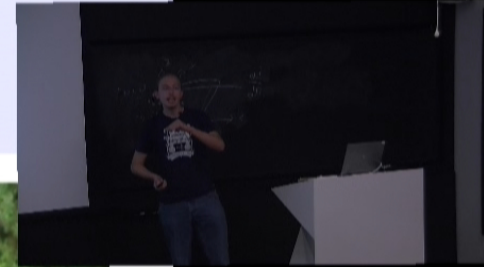
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# Sunset

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# Common Properties

## Mirages

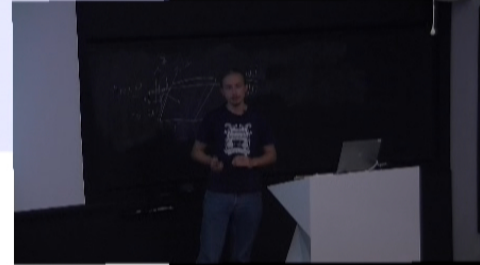
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- Distorted phantom images (sometimes multiple) of a single object (or parts thereof)
- Stacked vertically (superiour/inferiour mirage)
- Only visible from small angles
- Meteorological conditions (air layers) are crucial  
→ unstable!



# Principle of Least Time

Mirages

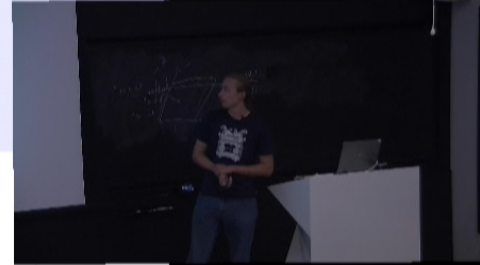
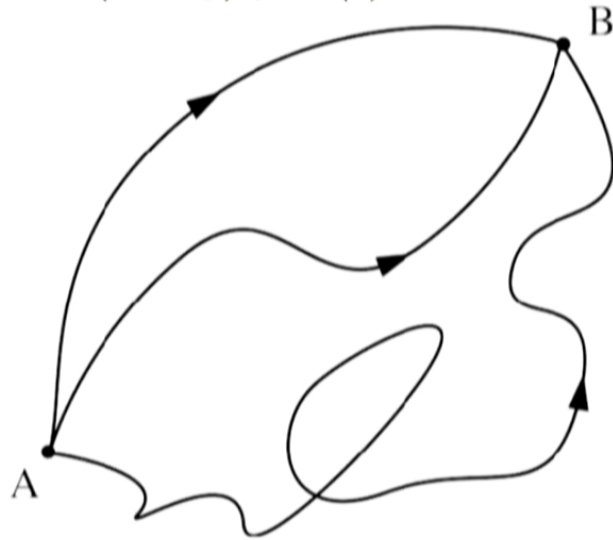
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Pierre de Fermat (1662): *Light rays always take the path(s) that (locally) yield(s) the shortest runtime!*



# Refractive Index

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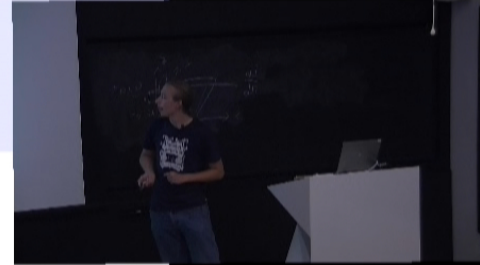
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Propagation of EM waves through a medium:  $v = \frac{c}{n}$   
→ Runtime along path:

$$t_{run} = \int dt = c \int n(s) ds$$

$n$  is temperature-dependent:  $(n - 1) \propto \rho \propto T^{-1}$   
⇒ light rays are bent towards warm air!





# Meteorology: The Highway Mirage

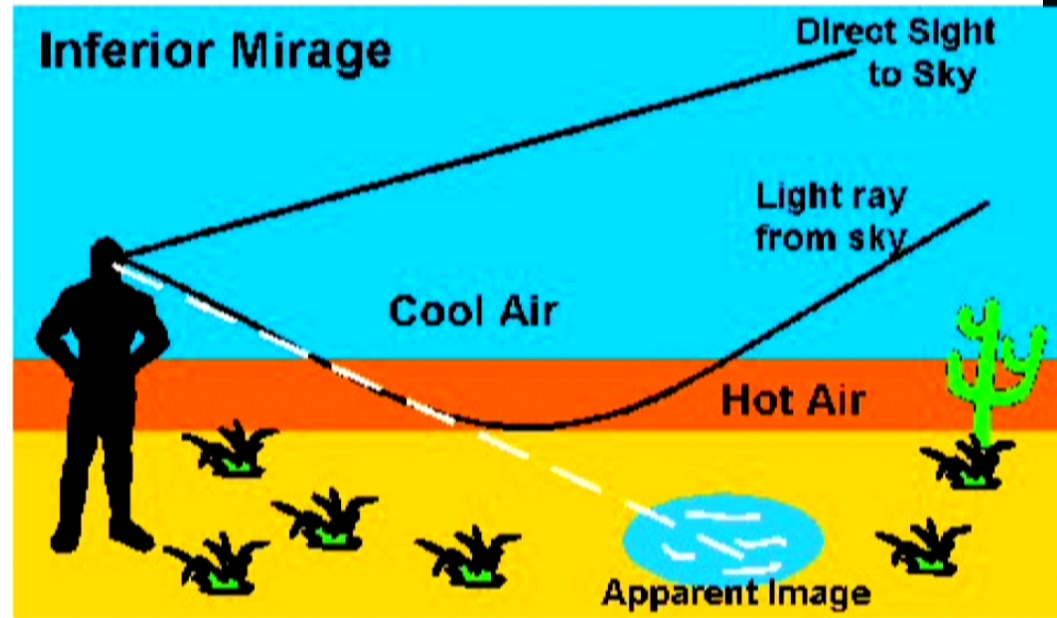
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# Meteorology: The Superior Mirage

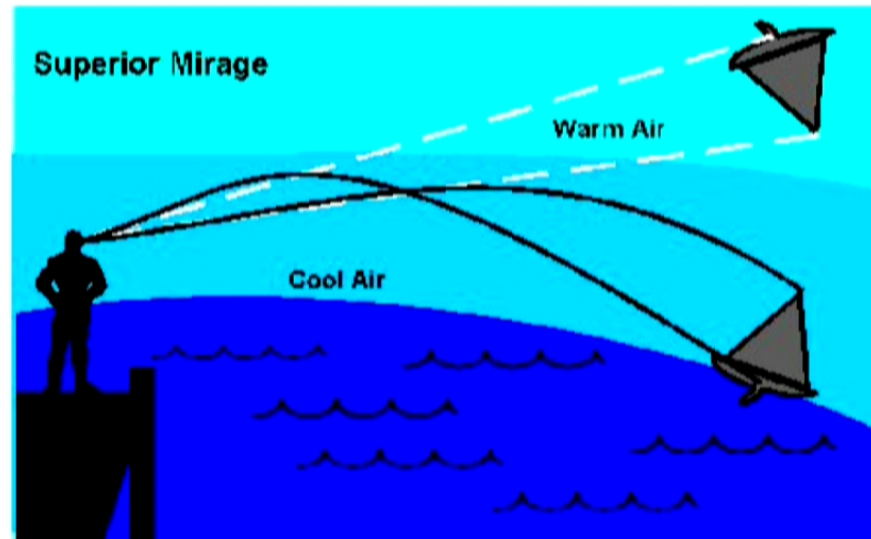
## Mirages

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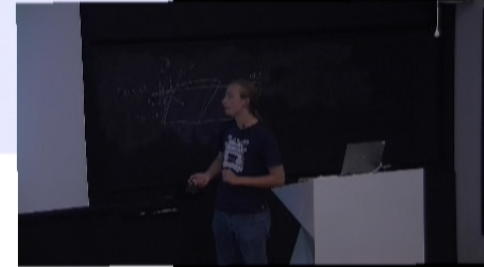
The Phenomenon

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- Only in case of an inversion layer → unstable!
- Tropospheric ducting



# Meteorology: The Superior Mirage

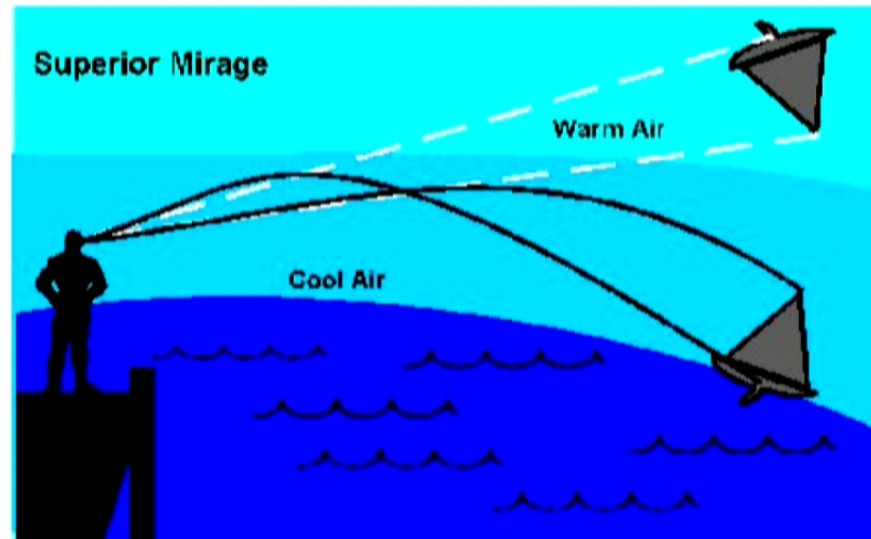
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Mirages

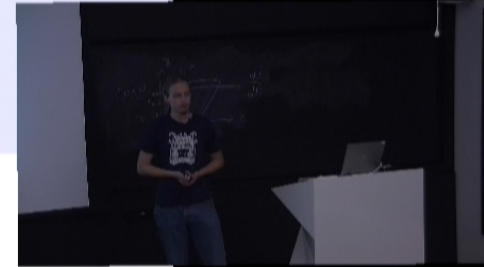
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# Strong Gravitational Lensing!



# Einstein Arcs

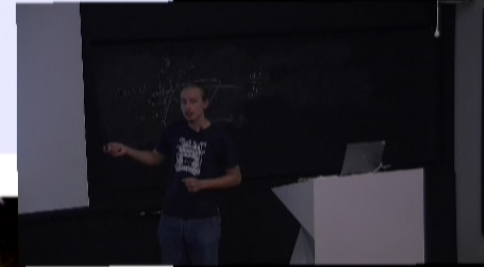
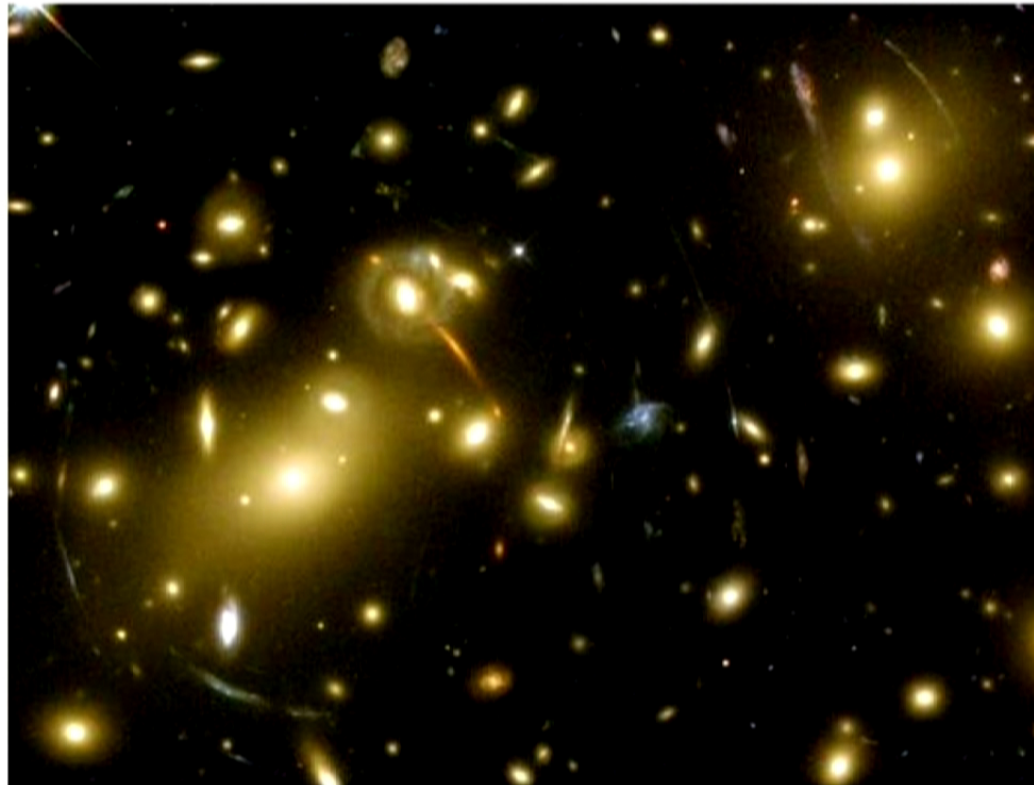
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# The Einstein Cross

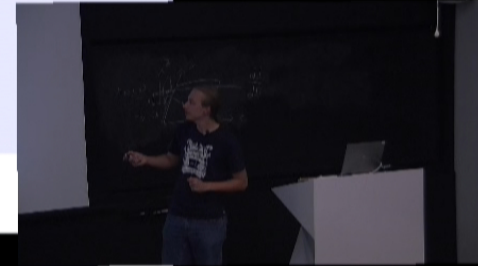
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# Old Faithful

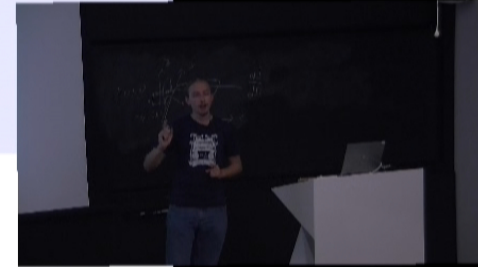
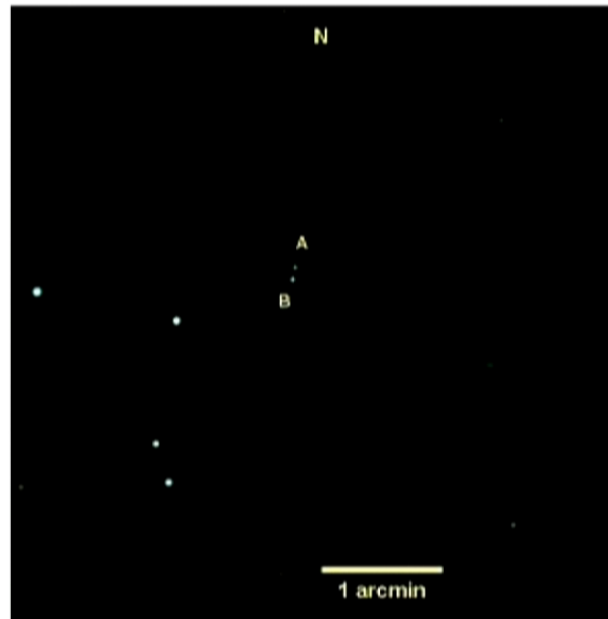
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## The Moral

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# Science replaces Superstition!

