[HRK (5e), ch 37]

Geometric optics

- we've considered scattering by small ($a \ll \lambda$) objects
  → Rayleigh scattering
- what about when objects are large ($a \gg \lambda$)?
  - e.g. mirrors, prisms, lenses
- radio astronomy: dishes are 100 m in size $\gg \lambda$
  because $\lambda = 3$ cm to 400 cm [3, 6, 21, 90, 400 cm]

When size of scattering objects is $\gg \lambda$
one can mostly ignore wavelike properties of light
and treat it as a ray travelling in a straight line.
(ignore $\vec{E}$ & $\vec{B}$, only $\vec{k}$)
[nature of approximate models]

Fermat's principle of least time: [Fermat of Fermat's last thm]
light travels between two points
along the path of shortest time.

Since speed of light is constant (in a vacuum
or a homogeneous medium), path of shortest
time is also the path of shortest distance,
i.e. a straight line.

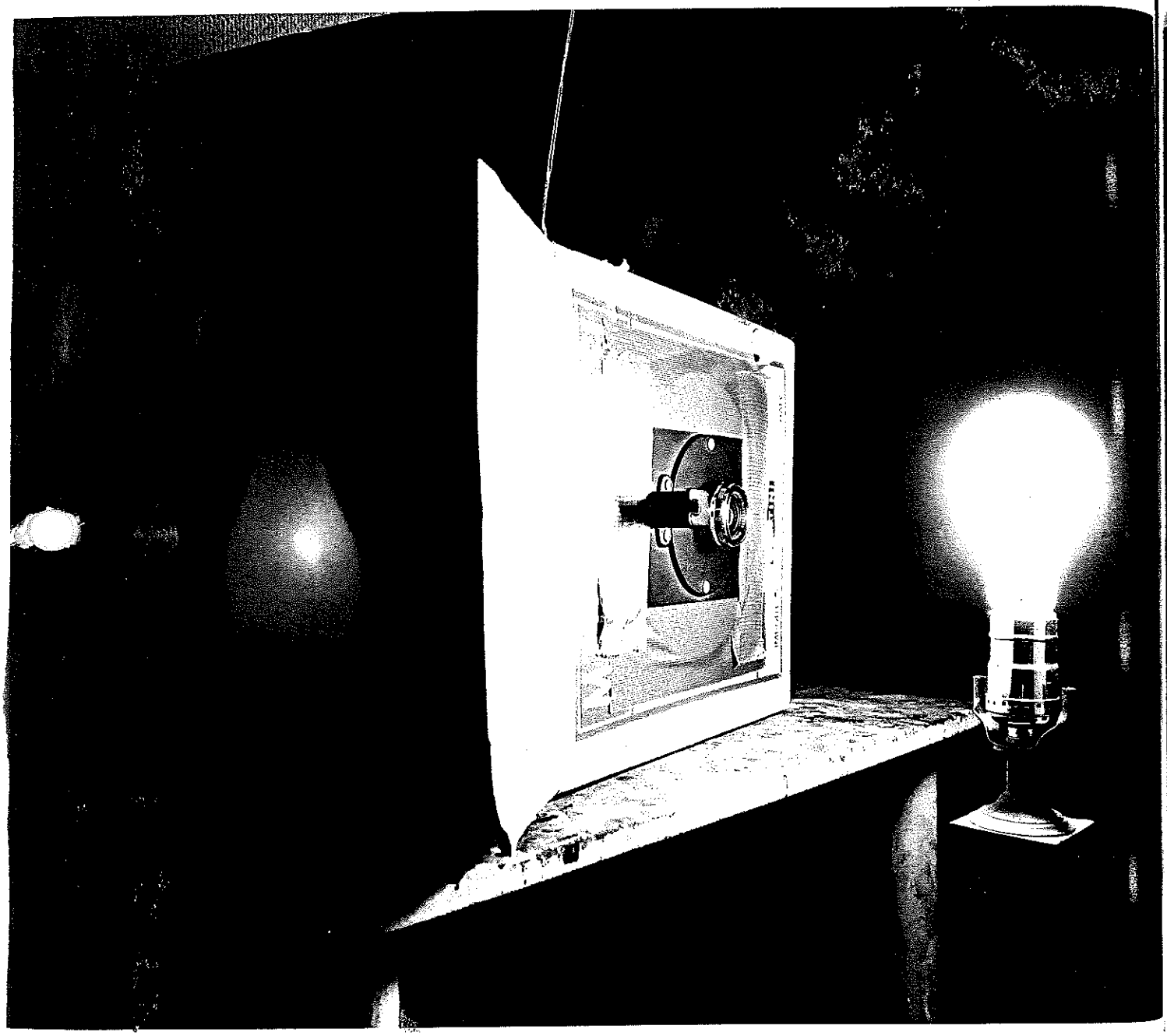
[implications of straight line]

- creation of shadows
- inversion of images created by a pinhole

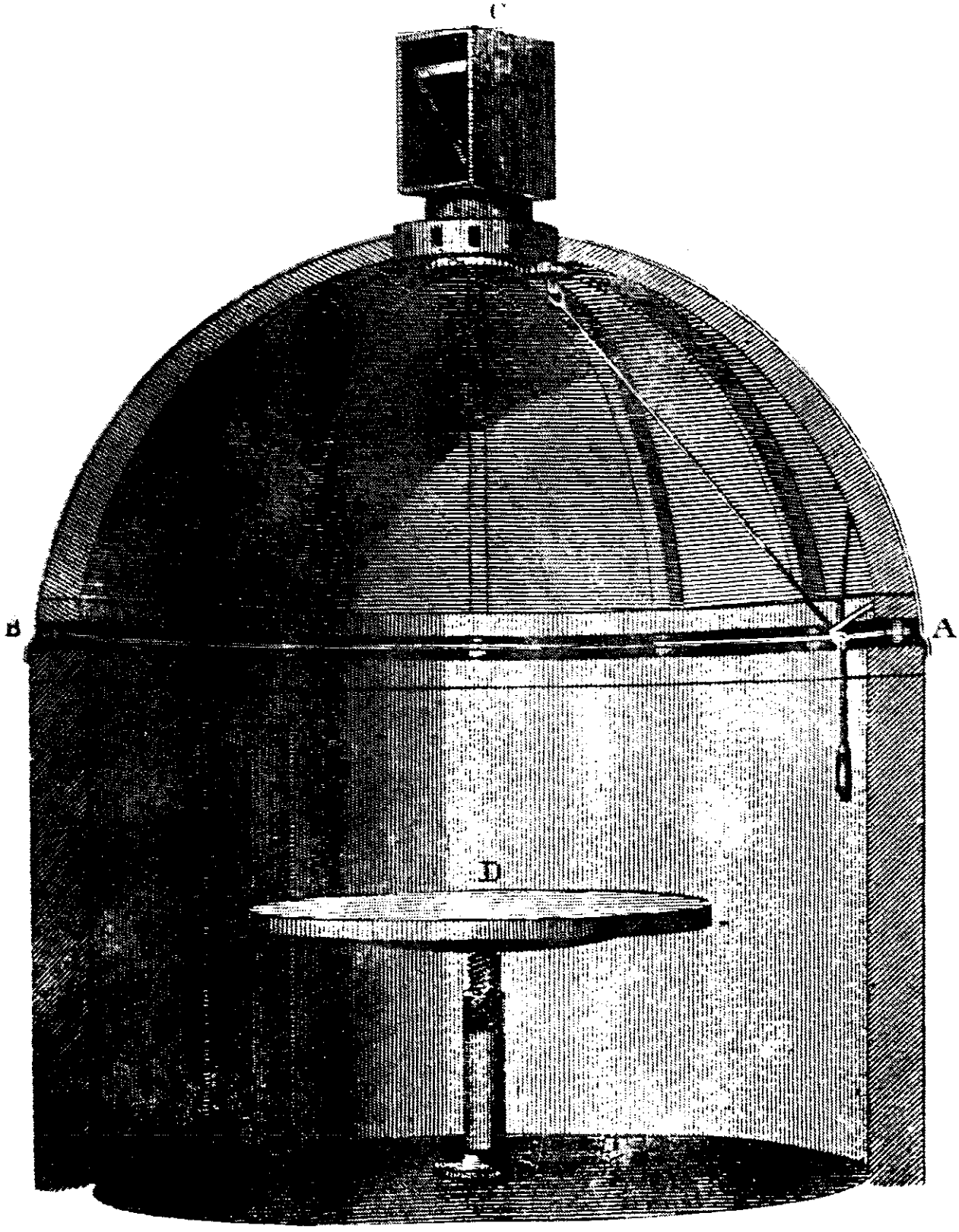
[photo of bulb,
camera obscura,
Abelardo Morrell '77 photos]

- inversion of image on retina

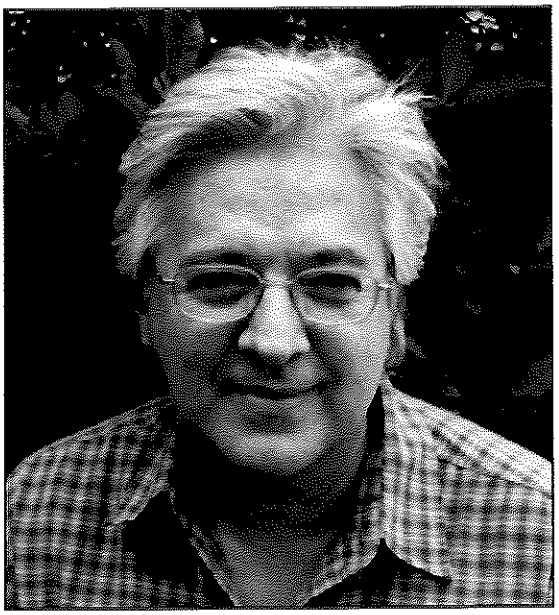
[brain reverses it; apply pressure to eyeball]



Light Bulb,1991


C
B
A
D

ABELARDO MORELL



***Abelardo Morell*, 2006**

Biography | Resume | Collections

Birth Date & Place

1948, Havana, Cuba

Education

Bowdoin College, Brunswick, ME: Bachelor o
Yale University School of Art, New Haven, CT
Bowdoin College, Brunswick, ME: Honorary D

- Presented by Professor John McKee, (
- Remarks by Abelardo Morell, (PDF; 3

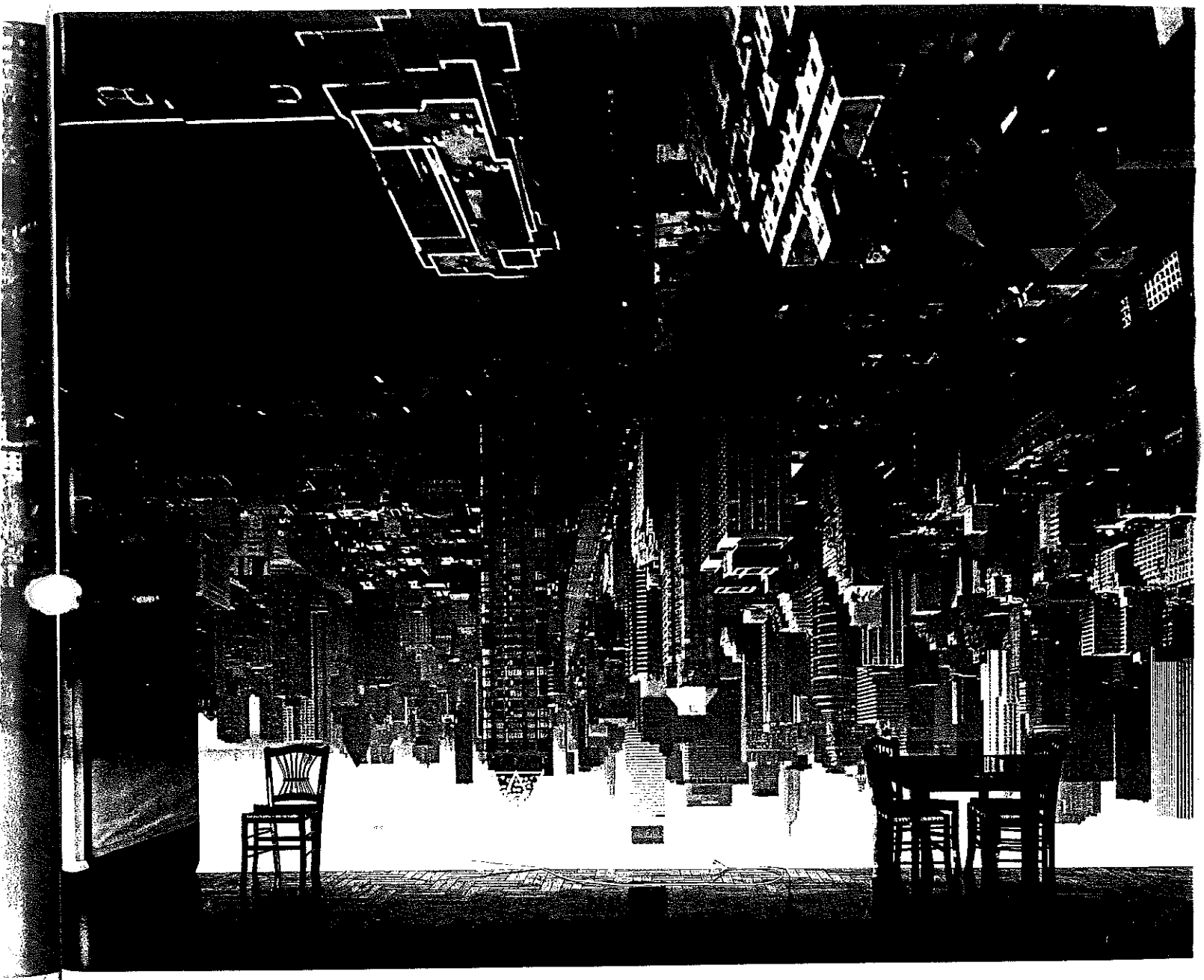
Artist Residencies

Alturas Foundation Artist-in-Residence,
south Texas, 2008-2009

Happy and Bob Doran Artist-in-Residence,
Yale University Art Gallery,
New Haven, CT, 2008-2009

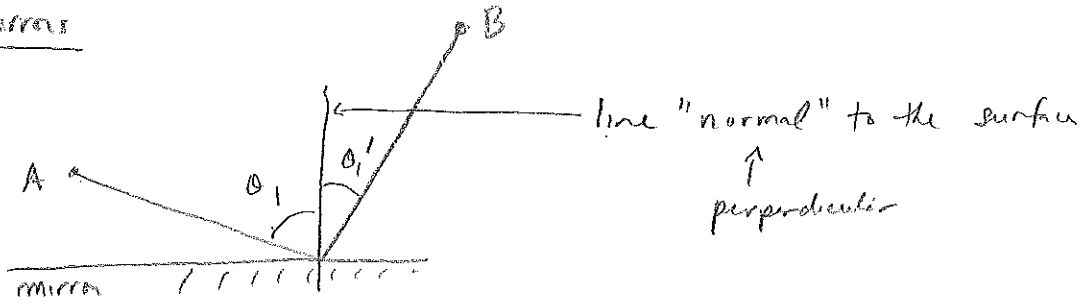
Awards

2011 International Center of Photography In
2009 Alturas Foundation Grant
2006 The Decordova Museum Rappaport Pr
1995 St Botolph's Club Foundation Award
1994 New England Foundation for the Arts F
1993 John Simon Guggenheim Memorial Fel
1992 Cintas Foundation Fellowship



Camera Obscura Image of Manhattan View Looking South
in Large Room, 1996

Mirrors

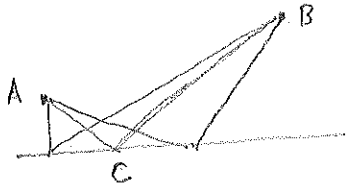


θ_1 = angle of incidence
θ_1' = angle of reflection

angles are measured with respect to the normal

What is the relation between θ_1 and θ_1'

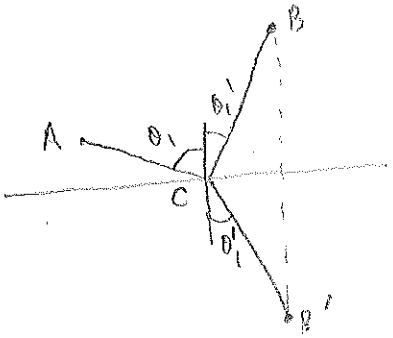
Fermat's principle of least time



ACB is shortest when $\theta_1' = \theta_1$.

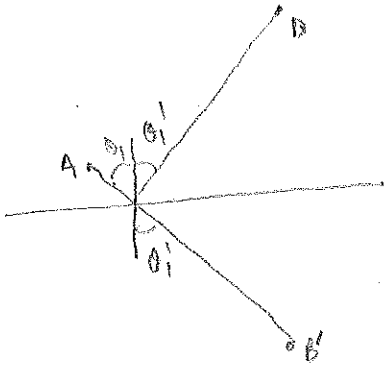
How to see this?

Draw B' on other side of mirror



Distance ACB = Distance ACB'

Distance ACB' is minimized for a straight line



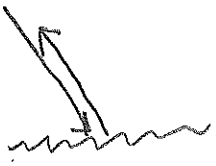
Alternate interior $\Rightarrow \theta_1' = \theta_1$

Law of specular reflection: $\theta_1' = \theta_1$

speculum = mirror

Retro reflectors: devices that always reflect light back in the direction it came from

(e.g. bicycle reflectors)



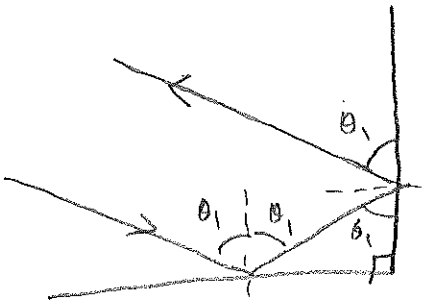
[reflects headlights back to eyes of driver]

[DEMO: big white laser w/ mask (6 inches diameter)

try w/ mirror, then w/ retro reflector]

close shutters

Corner reflector



reflected light is always parallel to incident

possibly omit → [DEMO: right angled plexiglass to demonstrate this]

[DEMO: hand around bicycle reflectors; ← (not Porros!)

also the 2 triple corner reflectors to see own eye]

Lunar laser ranging retroreflector array

[measure distance to moon within ± few cm.

moon recedes about 4 cm/year;

earth days getting longer]