[HRK (5e), ch 39]

Ray optics (geometric optics)

When size of scattering objects is $\gg \lambda$: (eg. mirrors, lenses)
we can largely ignore the wave nature of light, and instead treat it as a ray travelling in a straight line.

[How do we know light travels in a straight line?]

DEMO: Laser and chalk dust.

Evidence for rectilinear propagation

- shadow formation
- pinhole images (inverted)

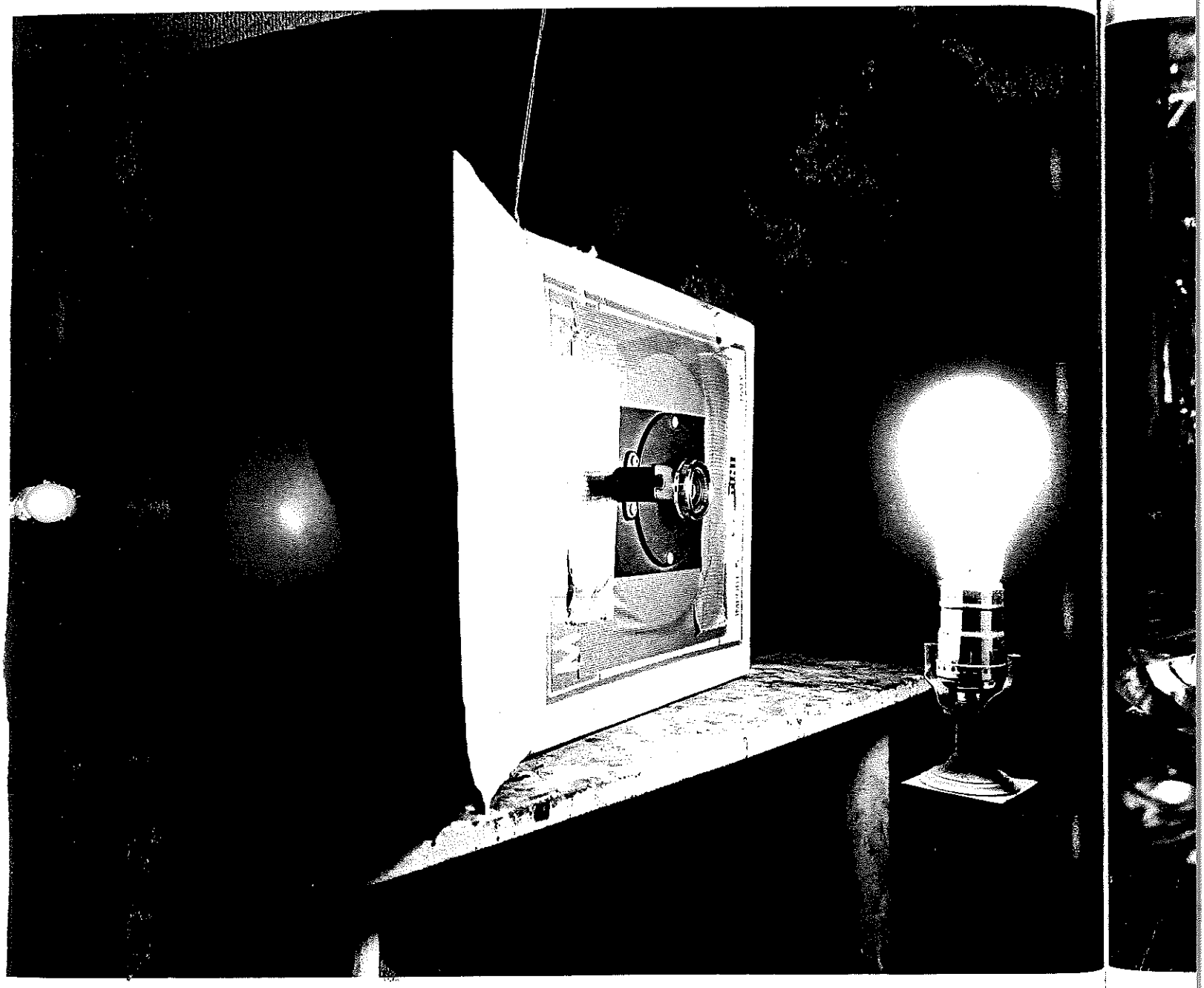
[photo of bulb]
(place blank transparency over it; draw lines w/ ruler)

[Camera obscura photo of NYC]

[Abe Morell, '77]

L2

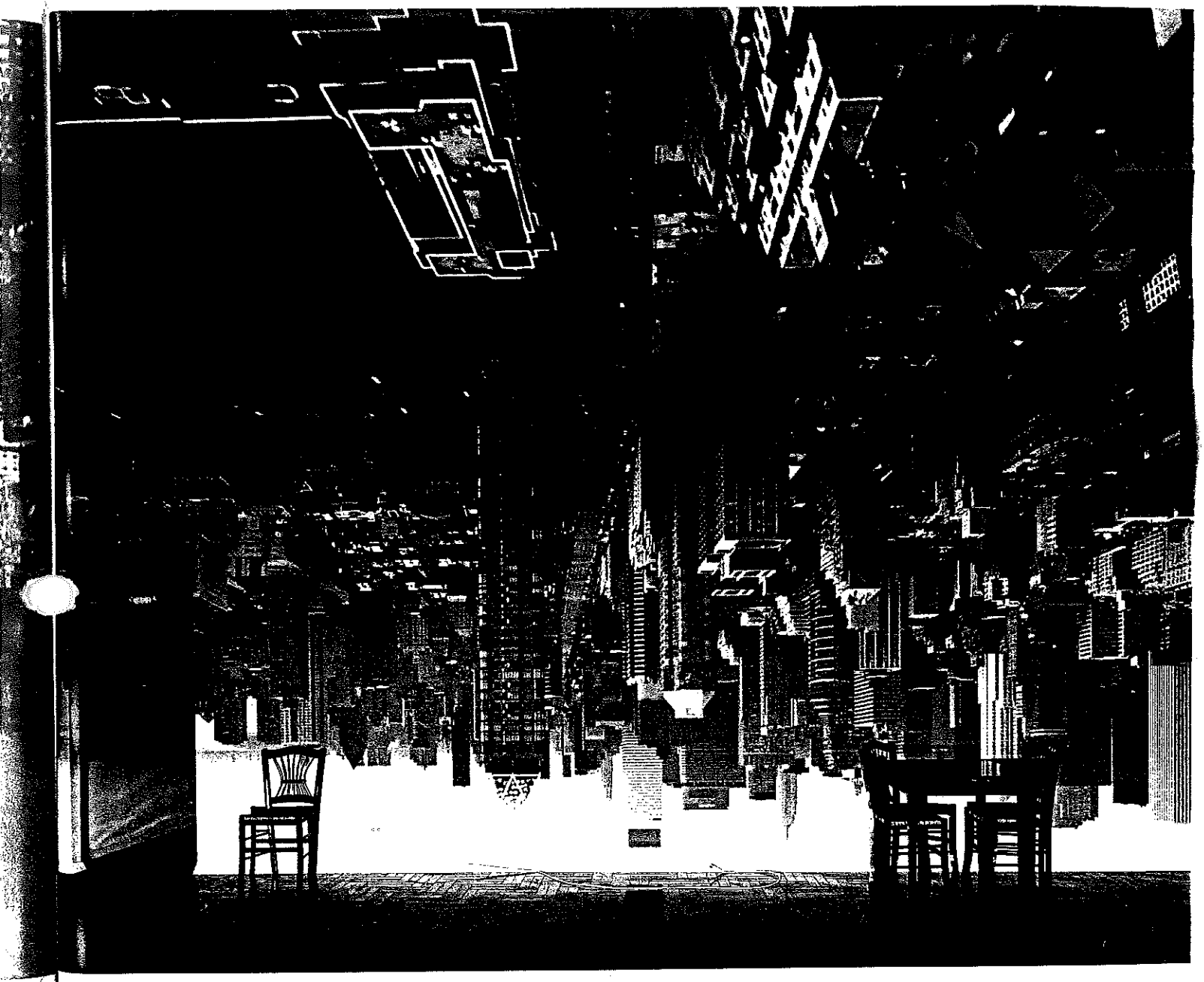
011



Light Bulb,1991

L3

011

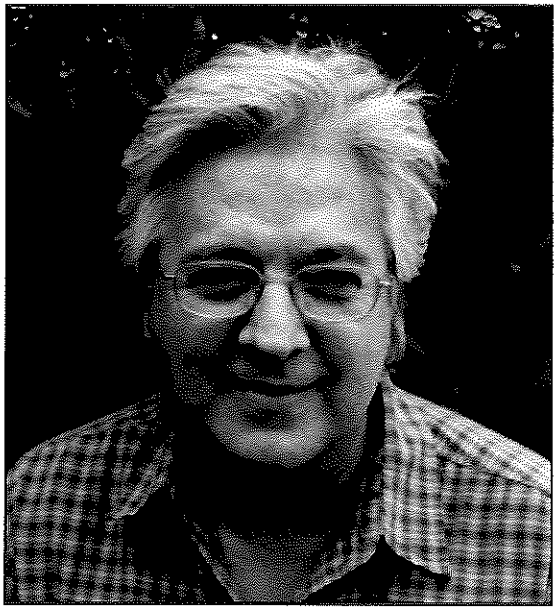


Camera Obscura Image of Manhattan View Looking South
in Large Room, 1996

L4

04

ABELARDO MORELL



***Abelardo Morell*, 2006**

Biography | Resume | Collections

Birth Date & Place

1948, Havana, Cuba

Education

Bowdoin College, Brunswick, ME: Bachelor of
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

Dark room = camera obscura

Camera.

Eye as a camera obscura.

Image on retina is inverted (brain reverses it)

[apply pressure to inner side of eye]

[Why does light travel in a straight line?]

Fermat's principle of least time (1662)

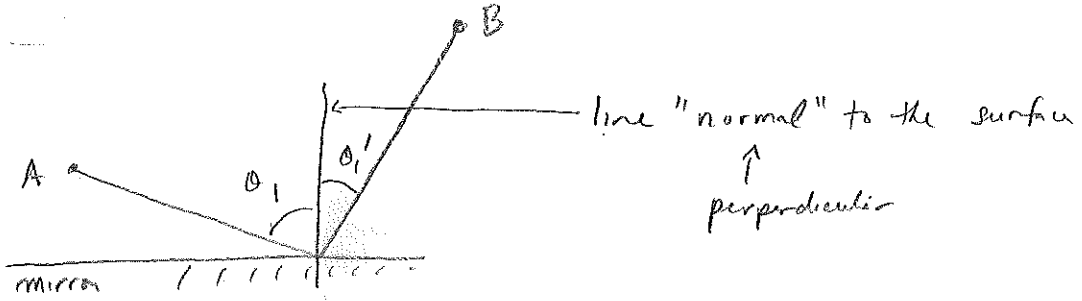
light travels between two points
along the path of shortest time

In vacuum (or in a homogeneous medium)
Speed of light is constant: $(d = ct)$

So path of shortest time is path of shortest distance.

Shortest distance between two points is a straight line

Reflection (scattering from a smooth surface)



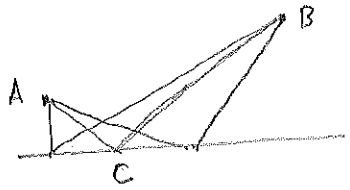
θ_1 = angle of incidence

θ_1' = angle of reflection

angles are measured with respect to the normal

What is the relation between θ_1 and θ_1'?

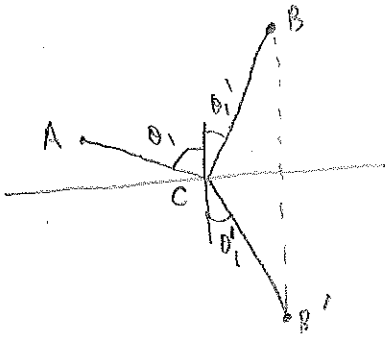
Fermat's principle of least time



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

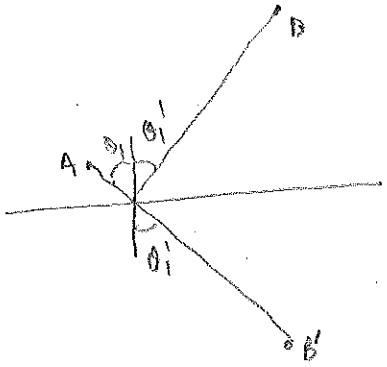
How to see this?

Draw B' on other side of mirror at same distance



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]

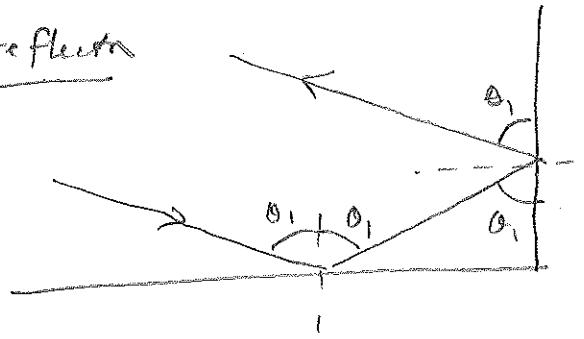
[Later, we'll see that reflection is really quick coordinated scattering (or cooperation) from electrons on the mirror surface, and that this coordination explains $\theta_1 = \theta_1'$]

Retroreflectors: devices that reflect light back in the direction from which it came (e.g. bicycle reflectors)

[reflects headlights back to eyes of driver]

DEMO: big white laser with mask.
First try mirror. Then use triple corner reflector.

Corner reflector



reflected light is parallel to incident

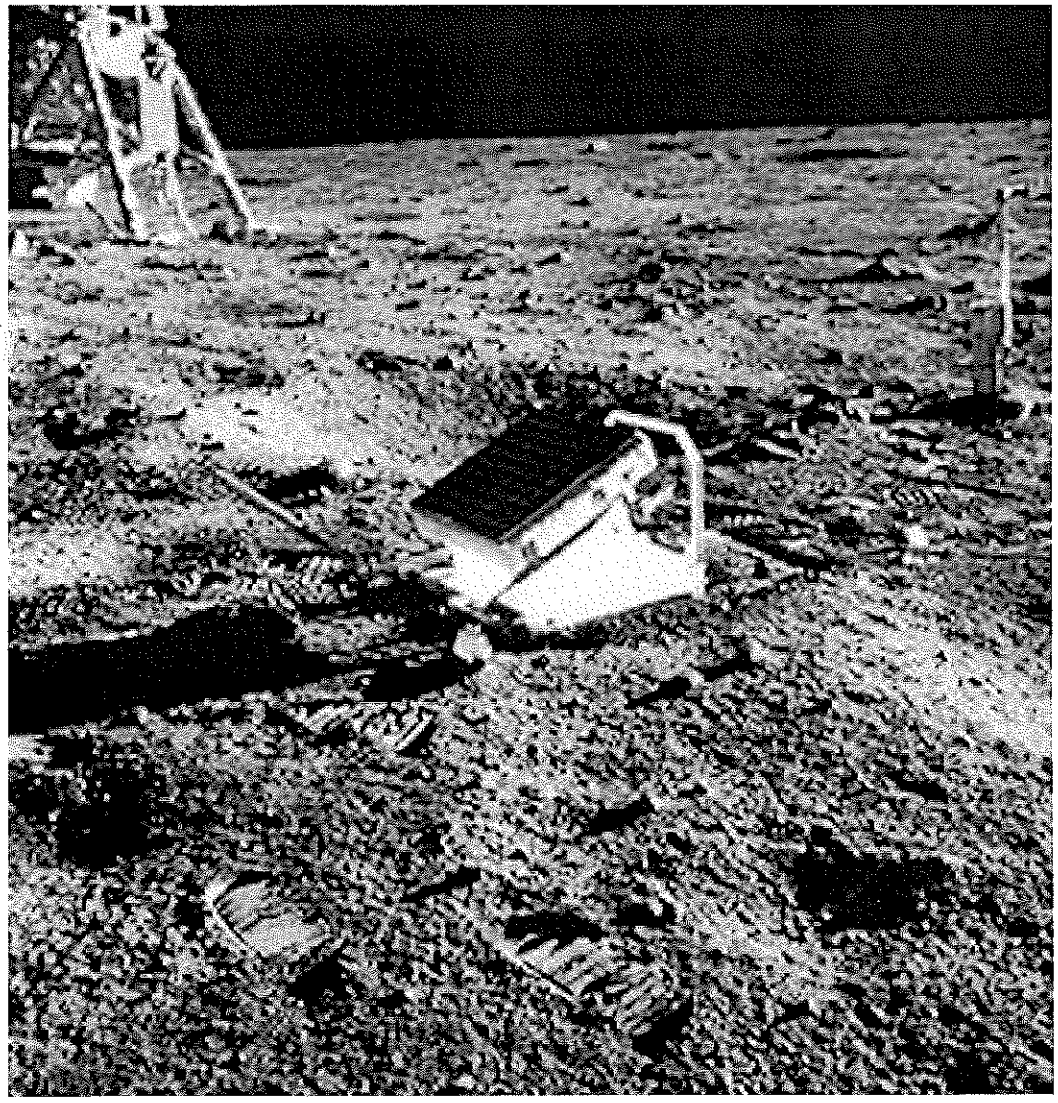
DEMO: use bicycle reflector w/ laser.
Then hand around bicycle reflectors.
Possibly also triple corner reflectors.

[Lunar laser ranging retroreflector array ⟹]

[measure distance to moon within ± few cm.
moon recedes from earth at 4 cm/yr.
Day getting longer]

L8

OH



Also in 1140.html

L9
OH

Also in 1140.html