today's lesson
Reflection of Light
a brief overview of Wave-Particle Duality
light and matter exhibit properties of both waves & particles
Light is Quantum Vector Field
Light has multiple personality
phenomena: when light hits the interface of two dissimilar media

wave–particle duality of light

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Wave Property</th>
<th>Particle Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>reflection</td>
<td>wave property</td>
<td>particle property</td>
</tr>
<tr>
<td>refraction</td>
<td>wave property</td>
<td>particle property</td>
</tr>
<tr>
<td>interference</td>
<td>wave property</td>
<td></td>
</tr>
<tr>
<td>diffraction</td>
<td>wave property</td>
<td></td>
</tr>
<tr>
<td>polarization</td>
<td>wave property</td>
<td></td>
</tr>
<tr>
<td>photoelectric effect</td>
<td></td>
<td>particle property</td>
</tr>
</tbody>
</table>

http://hyperphysics.phy-astr.gsu.edu/

https://micro.magnet.fsu.edu/
a brief discussion on light reflection
angle of incidence $\angle i$

angle of reflection $\angle r$

"NORMAL" = perpendicular to the surface

incident ray

reflected ray

surface
law of reflection

if the incident beam falls along the normal, the ray reflects back along the normal
law of reflection

if the incident beam falls at an acute angle, angle of incidence = angle of reflection

\[ \angle i = \angle r < 90^\circ \]
law of reflection

incident and reflected beams are coplanar
different types of light reflection
mirror reflection

specular reflection

diffuse reflection
reflection of plane wavefront

incident wavefront

reflected wavefront
reflection of circular wavefront

source

incident wavefront

reflected wavefront
light scattering corresponds to
diffuse reflection

- wavelength changes
- frequency changes
- intensity changes
- energy changes
examples of light scattering in practical life

http://images.tutorvista.com/
http://www.olympusmicro.com/
<table>
<thead>
<tr>
<th><strong>specular reflection</strong></th>
<th><strong>diffuse reflection</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>takes place at glossy surfaces</td>
<td>takes place at rough/matte surfaces</td>
</tr>
<tr>
<td>parallel incident beam is reflected as parallel beam</td>
<td>parallel incident beam is reflected as deviated irregular trajectory</td>
</tr>
<tr>
<td>image formation</td>
<td>no image formation</td>
</tr>
<tr>
<td>corresponds to the color of the light source</td>
<td>gives color of the object</td>
</tr>
</tbody>
</table>
what is retroreflection?
prime principle: specially constructed reflection system

reflected beam travels out in the same direction of the incident beam

diverse mechanism of retroreflection

useful links

https://spie.org/

http://www.atoptics.co.uk/

http://www.physicsclassroom.com/

http://hyperphysics.phy-astr.gsu.edu/

https://www.sciencedaily.com/terms/wave-particle_duality.htm

http://webs.morningside.edu/slaven/Physics/uncertainty/uncertainty2.html