

SPIE. FIELD
GUIDE

Field Guide to
**Geometrical
Optics**

John E. Greivenkamp

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Otherwise, it leaves the original page numbering.

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EXHIBIT 1030

Field Guide to

Geometrical Optics

John E. Greivenkamp

SPIE Field Guides
Volume FG01

John E. Greivenkamp, Series Editor

SPIE PRESS
Bellingham, Washington USA

Library of Congress Cataloging-in-Publication Data

Greivenkamp, John E.
Field guide to geometrical optics / John E. Greivenkamp
p. cm.-- (SPIE field guides)
Includes bibliographical references and index.
ISBN 0-8194-5294-7 (softcover)
1. Geometrical optics. I. Title II. Series.

QC381.G73 2003
535'.32--dc22

2003067381

Published by

SPIE—The International Society for Optical Engineering
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Bellingham, Washington 98227-0010 USA
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Printed in the United States of America.
Third printing

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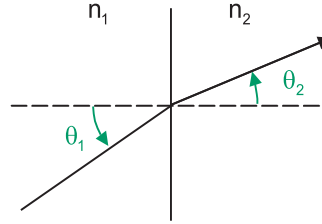
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Refraction and Reflection

Snell's law of refraction:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

The incident ray, the refracted ray and the surface normal are coplanar.

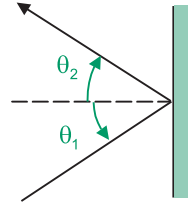


When propagating through a series of parallel interfaces, the quantity $n \sin \theta$ is conserved.

Law of reflection:

$$\theta_1 = -\theta_2$$

The incident ray, the reflected ray and the surface normal are coplanar.



Reflection equals refraction with $n_2 = -n_1$.

Total internal reflection TIR occurs when the angle of incidence of a ray propagating from a higher index medium to a lower index medium exceeds the **critical angle**.

$$\sin \theta_C = \frac{n_2}{n_1}$$

At the critical angle, the angle of refraction θ_2 equals 90°

The **reflectance** ρ of an interface between n_1 and n_2 is given by the **Fresnel reflection coefficients**. At normal incidence with no absorption,

$$\rho = \left(\frac{n_2 - n_1}{n_2 + n_1} \right)^2$$

n_1	θ_C
1.3	50.3°
1.4	45.6°
1.5	41.8°
1.6	38.7°
1.7	36.0°
1.8	33.7°
1.9	31.8°
2.0	30.0°

Critical angles
for $n_2 = 1.0$