Spectral Effects:
Chromatic Refraction and Wavelength Interference

Oregon State University

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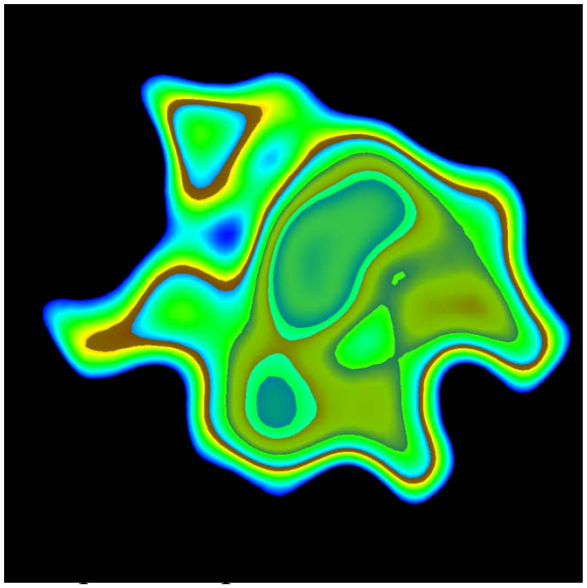
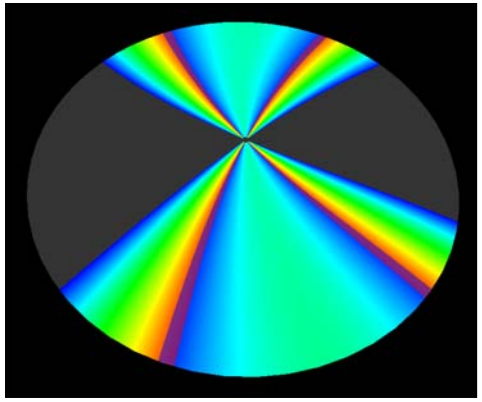
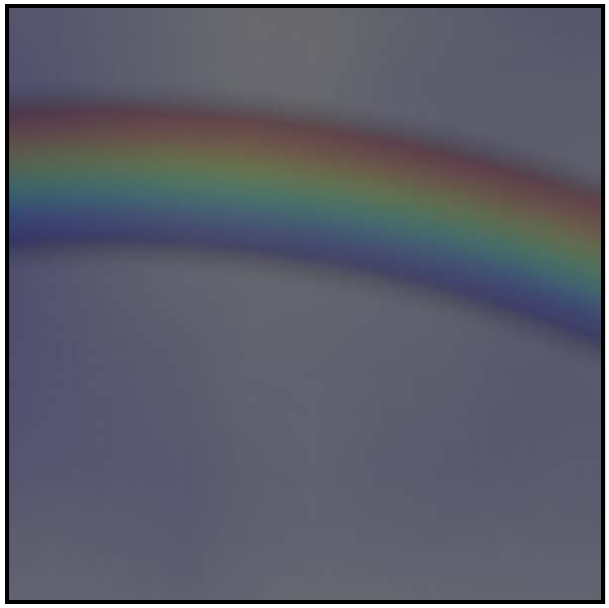


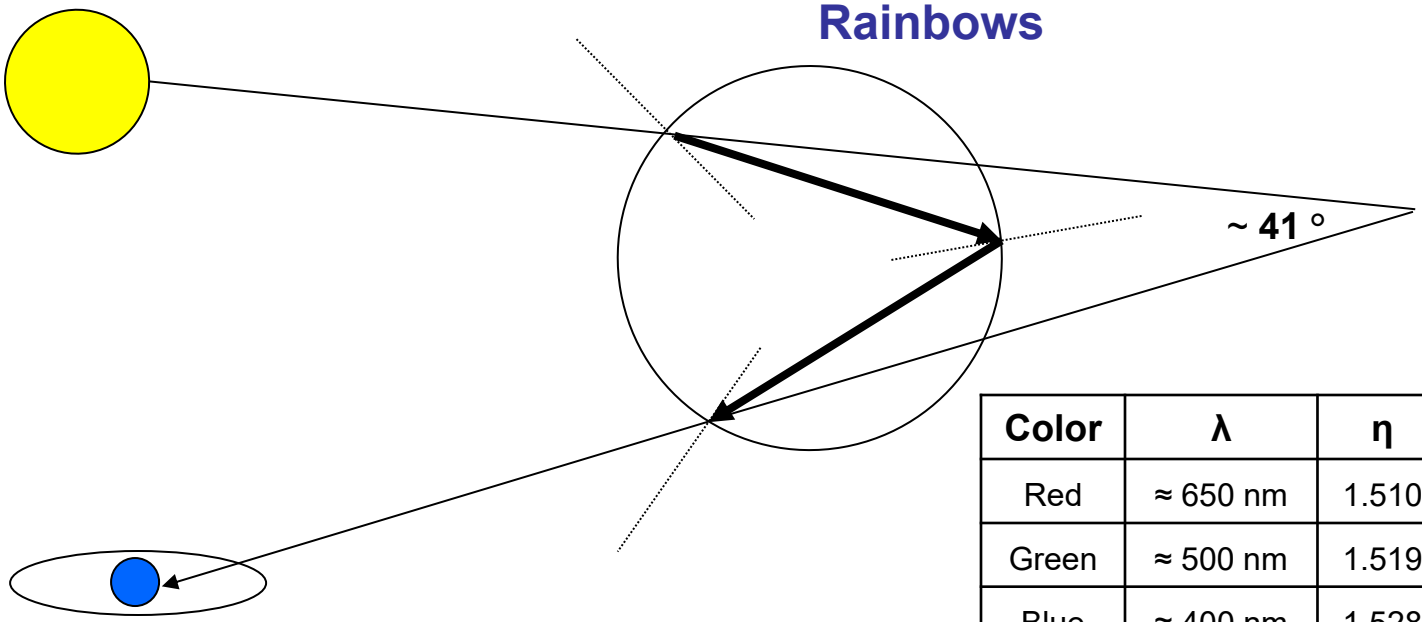




All You *Pink Floyd* Fans Already Understand Spectral Behavior . . . ☺

Certain processes result in a different light color being seen in a different place

Rainbows



Primary Rainbow

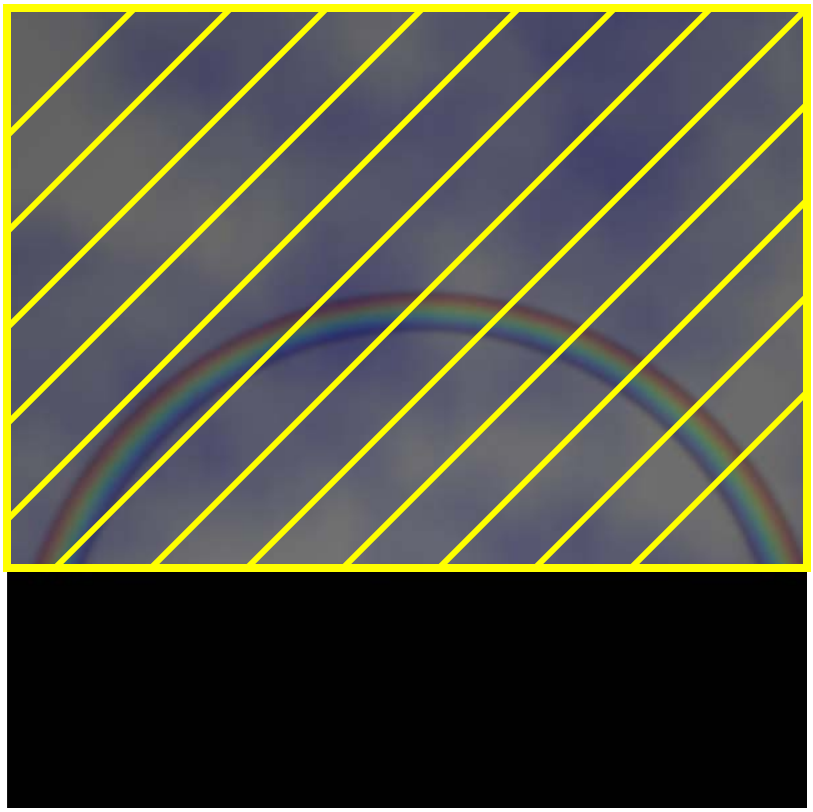
Secondary Rainbow

Color	λ	η	Θ	cosΘ	ΘΘ
Red	≈ 650 nm	1.510	42°	0.743	50.0°
Green	≈ 500 nm	1.519	41°	0.755	51.5°
Blue	≈ 400 nm	1.528	40°	0.766	53.0°

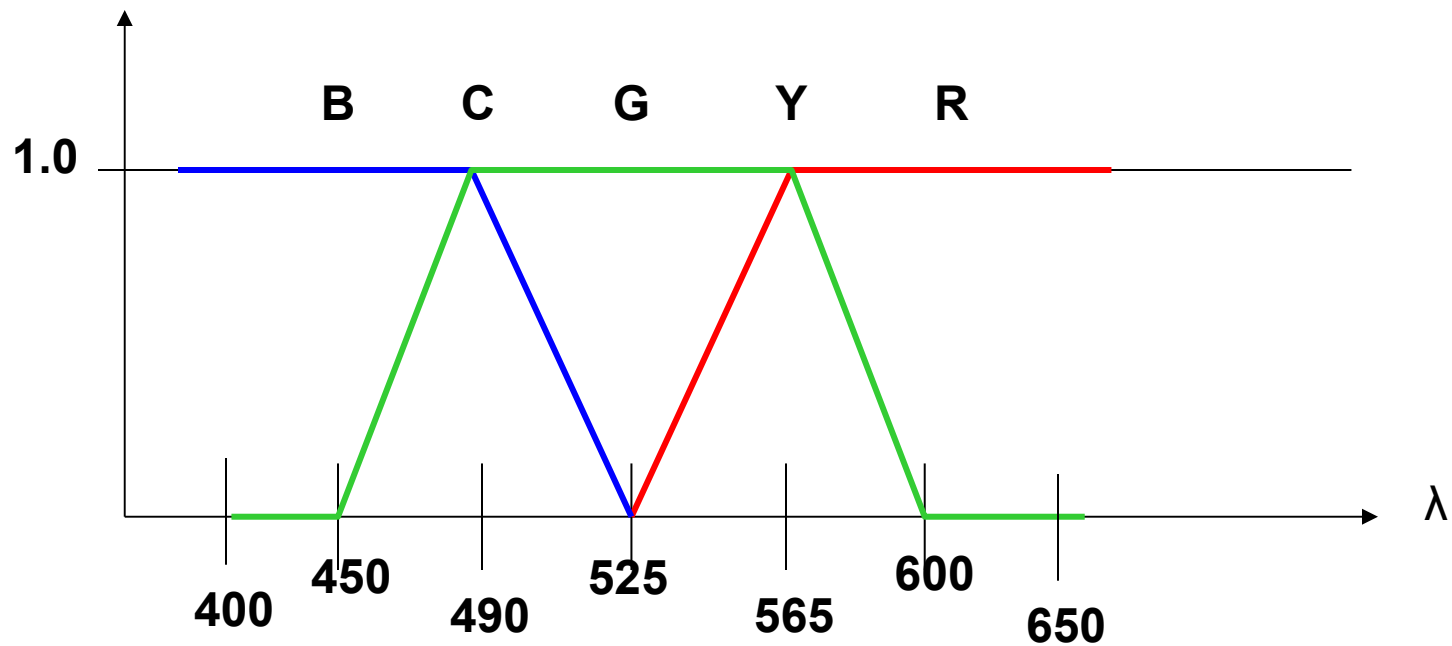
Rainbow Strategy

Or anything else, really. You just need a large "fragment-generator".

1. Draw one big quadrilateral across the scene
2. Anywhere that $.7400 \le \cos(\Theta) \le .7700$, paint a color
3. Otherwise, discard.



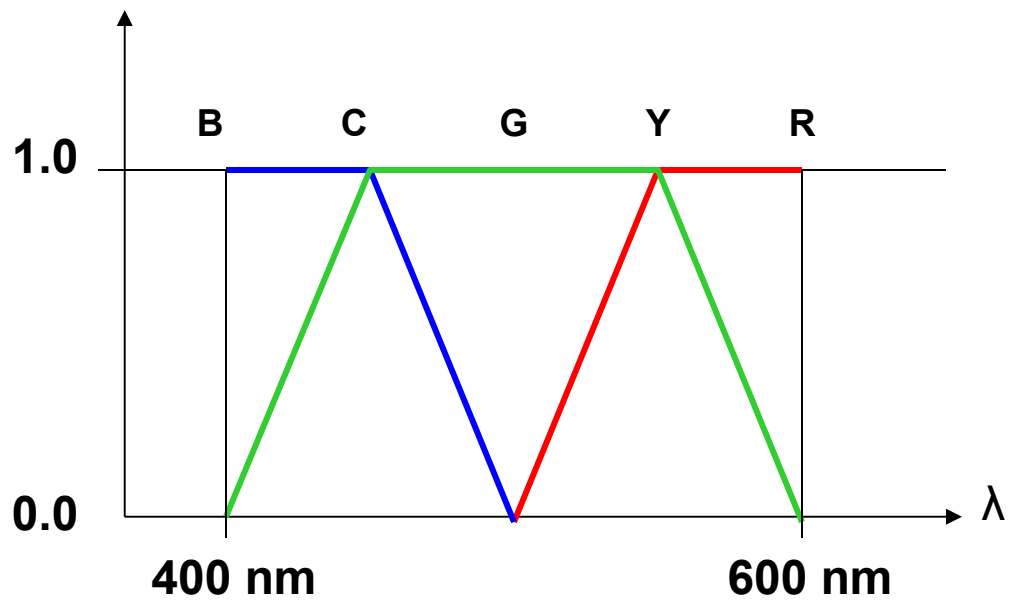
Spectral Colors




```
float
Pulse( float min, float max, float tol, float t )
{
    float a = min - tol;
    float b = min + tol;

    float c = max - tol;
    float d = max + tol;

    return  smoothstep(a,b,t) - smoothstep(c,d,t);
}
```

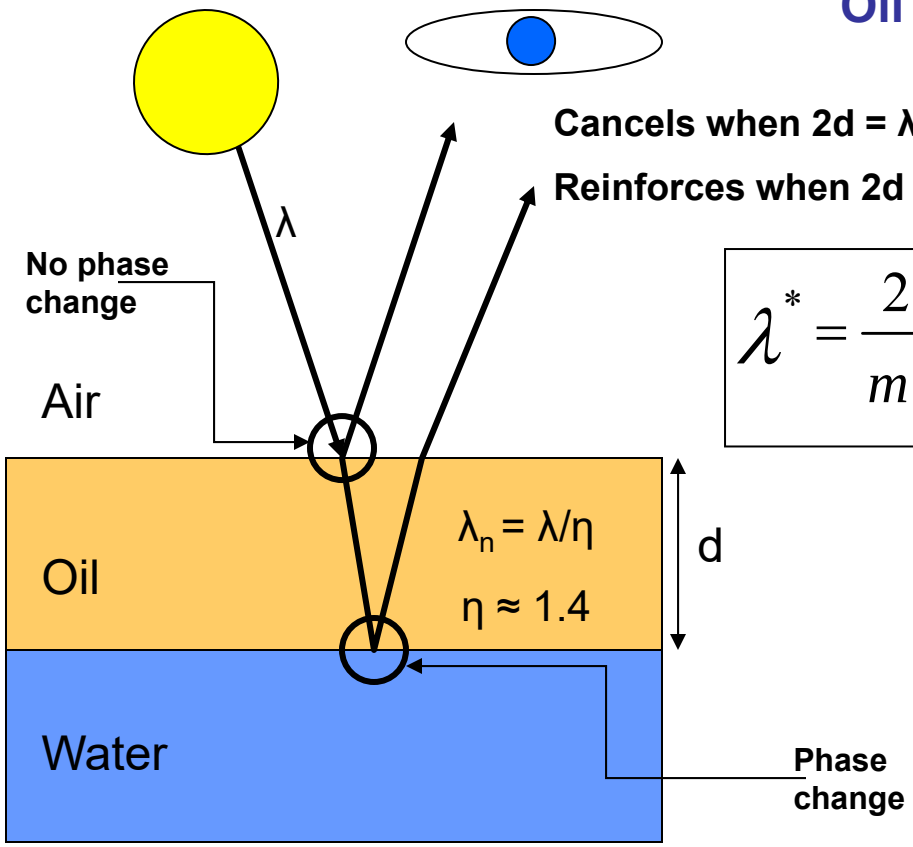
```
vec3 SunDirection = vec3( 0., SunY, 10. );
vec3 PtToSun = normalize( SunDirection );
vec3 PtToEye = normalize( vec3(0.,0.,0.) - ECposition );
float costheta = dot( PtToEye, PtToSun );

float R = Pulse( .7400, .7490, Tol, costheta );
float G = Pulse( .7490, .7605, Tol, costheta );
float B = Pulse( .7605, .7700, Tol, costheta );
```

Spectral Colors




```
float t = ( λ – 400. ) / ( 600. – 400. );
vec3 rgb = Rainbow( t );
```

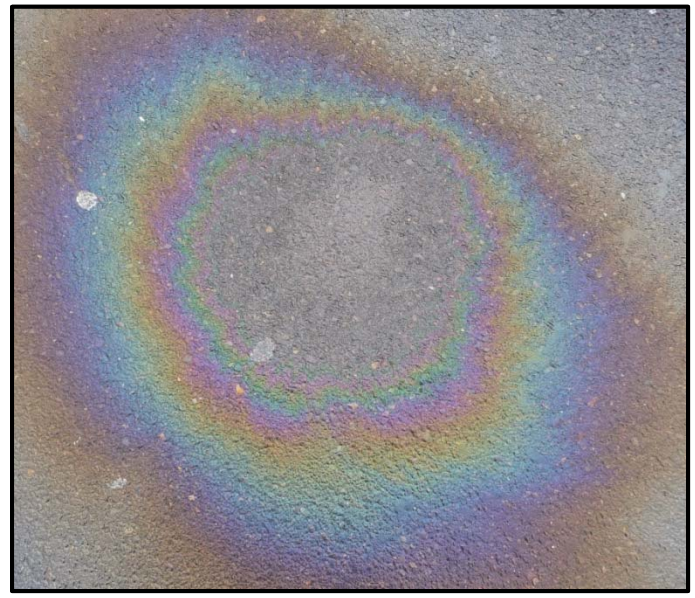
Oil Slicks

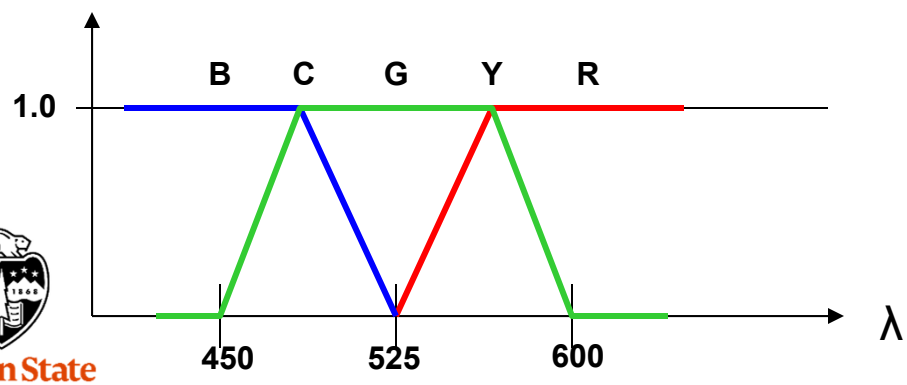


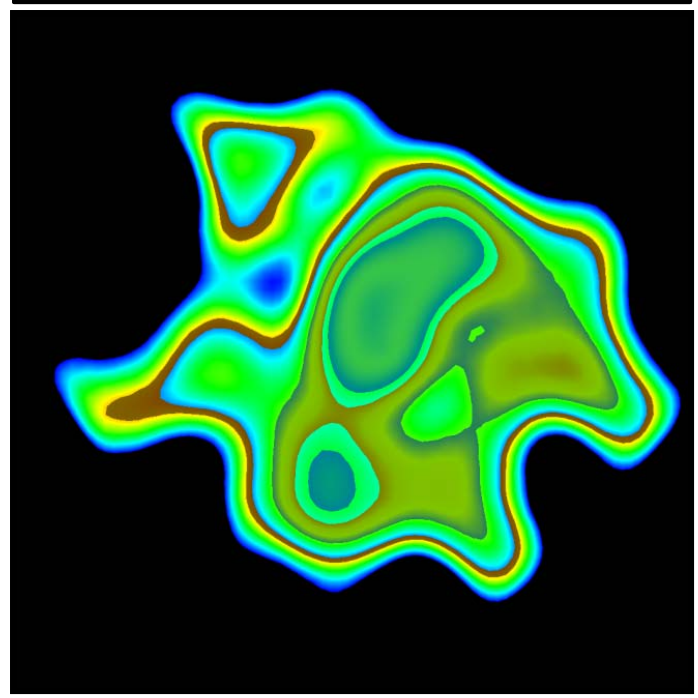
Cancels when $2d = \lambda_n \cdot (m)$

Reinforces when $2d = \lambda_n \cdot (m+½)$

$$\lambda^* = \frac{2d\eta}{m + \frac{1}{2}}$$







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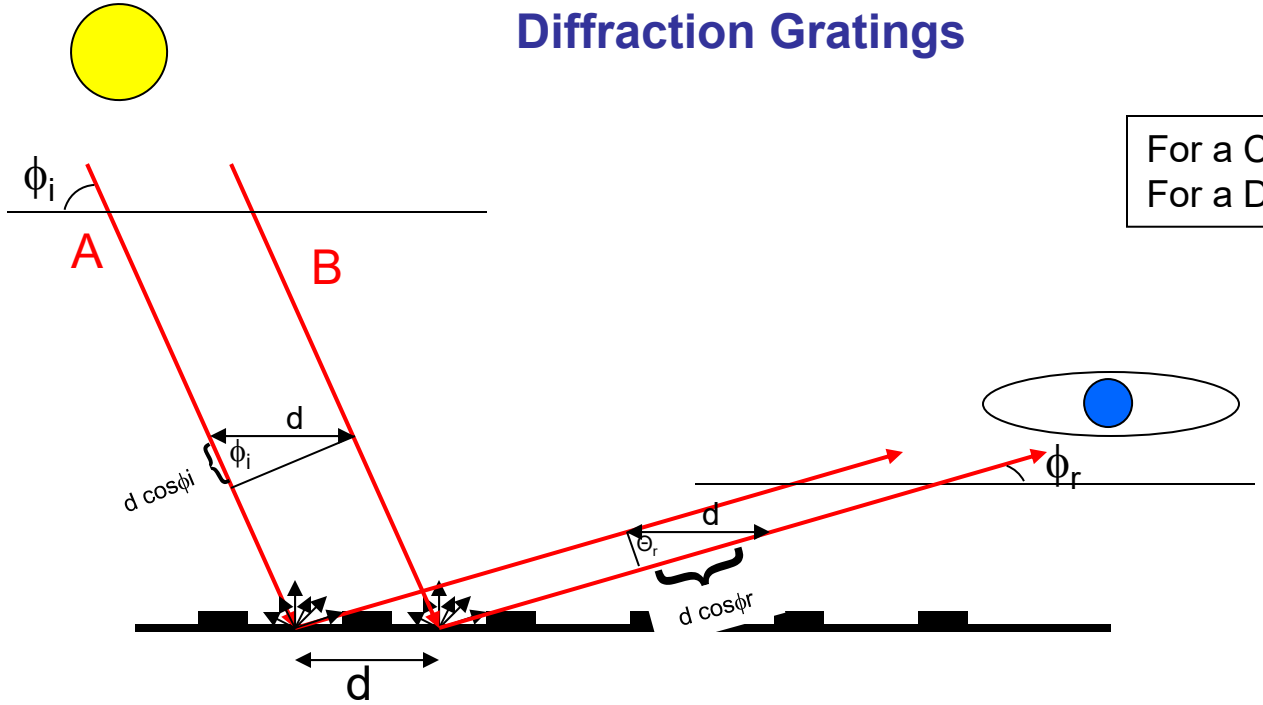
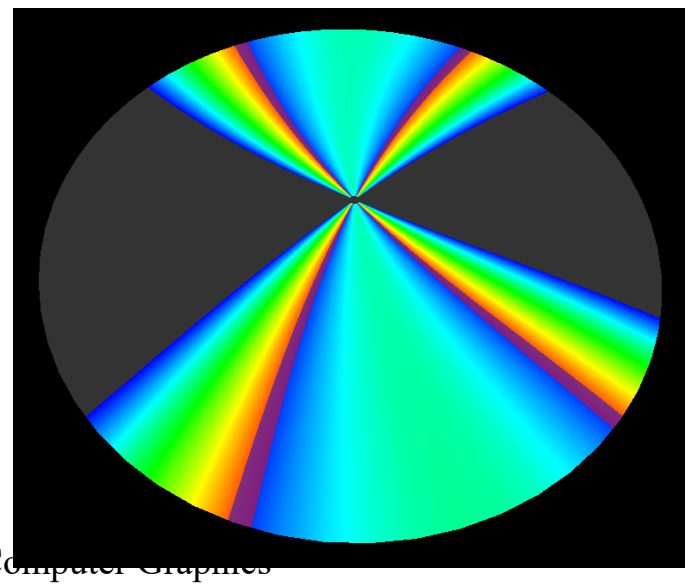
Computer Graphics

Diffraction Gratings

For a CD, d = 1600 nm
For a DVD, d = 740 nm

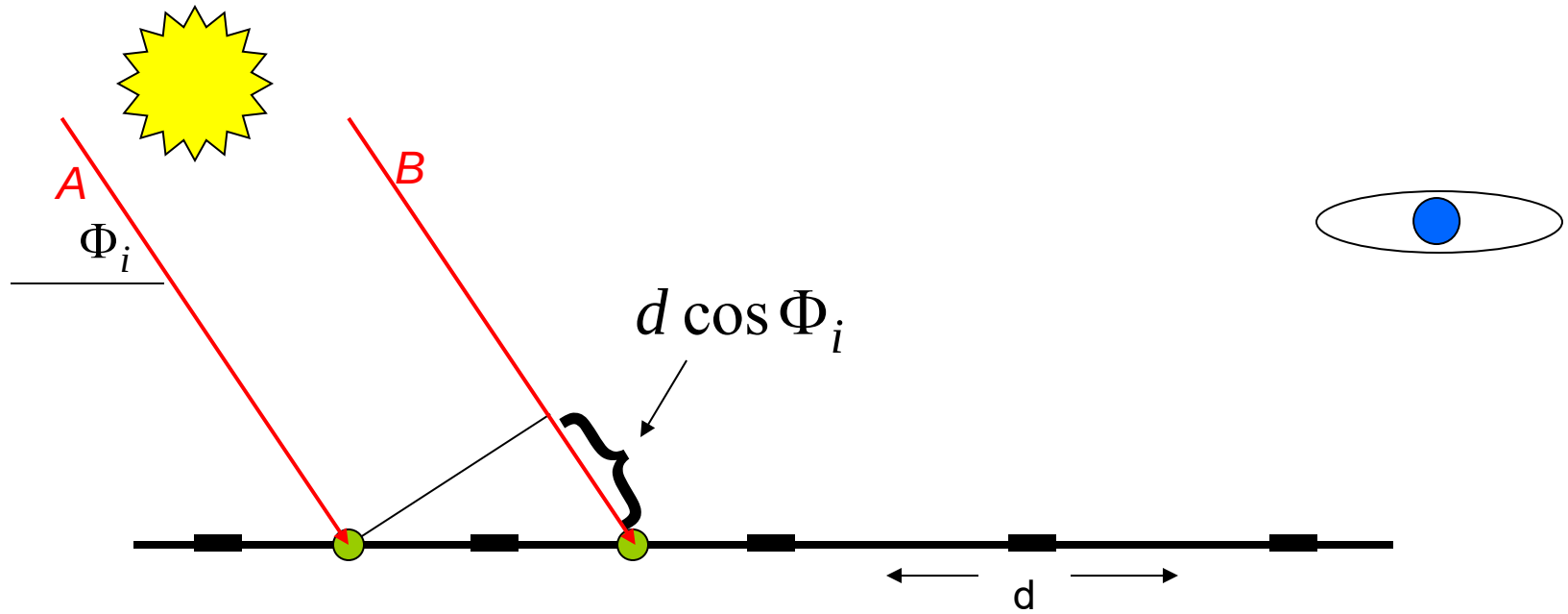


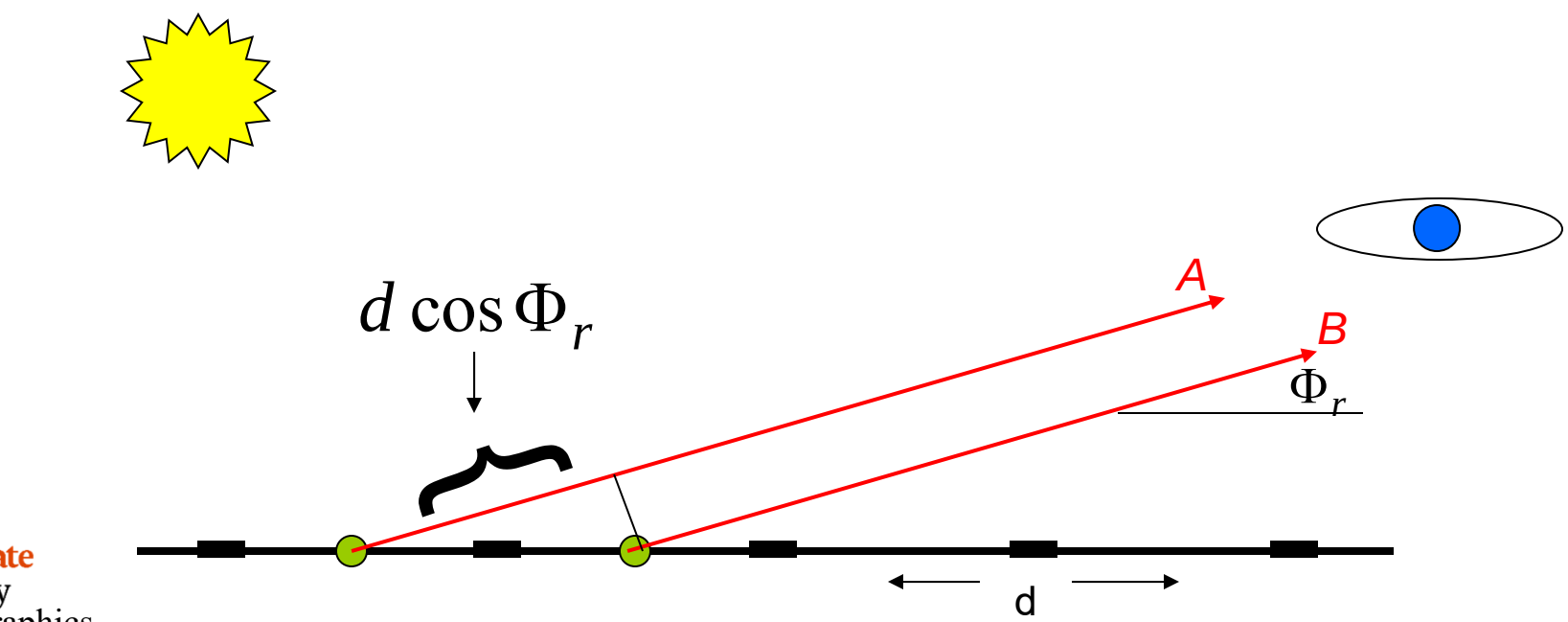


On the way in, Ray A travels dcos(ϕ_i) *less* than Ray B. On the way out, Ray A travels dcos(ϕ_r) *more* than Ray B.

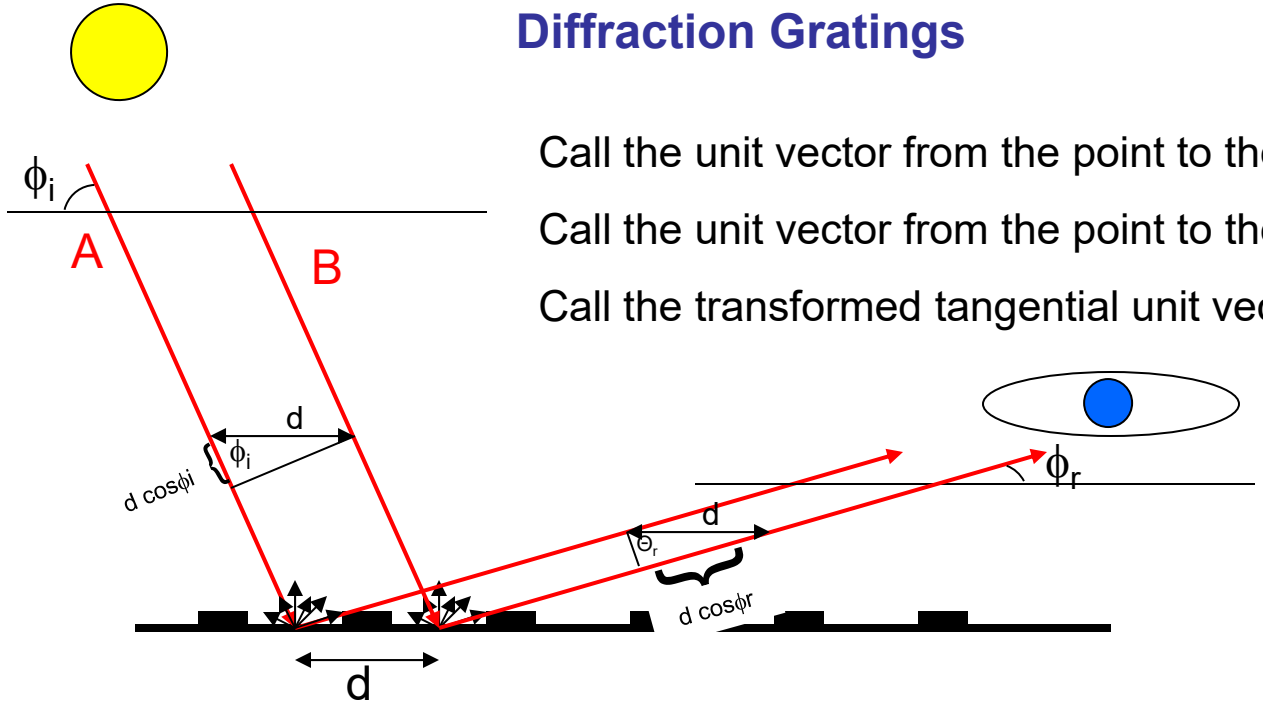
So, wavelengths reinforce when abs[dcos(ϕ_i) - dcos(ϕ_r)] is a multiple of the wavelength = mλ

$$\lambda^* = d \times | \cos(\phi_i) - \cos(\phi_r) | \ / \ m$$


A
B
Φ_i
$d \cos \Phi_i$
d


$d \cos \Phi_r$
A
B
Φ_r
d

Diffraction Gratings



Call the unit vector from the point to the light **ToLight**.

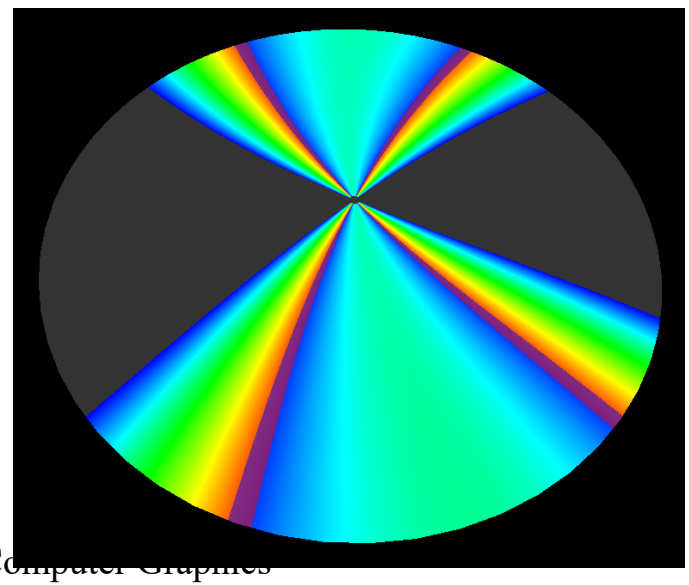
Call the unit vector from the point to the eye **ToEye.**

Call the transformed tangential unit vector **Tangent.**

Then, $\cos(\phi_i)$ is *ToLight•Tangent*

And, $\cos(\phi_r)$ is *ToEye•(-Tangent)*

So that $\cos(\phi i) - \cos(\phi r)$ is: *Tangent•(ToLight + ToEye)*



$$\lambda^* = d \times | \cos(\phi_i) - \cos(\phi_r) | \; / \; m$$