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Spectral Effects:
Chromatic Refraction and Wavelength Interference

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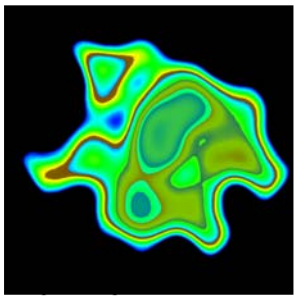
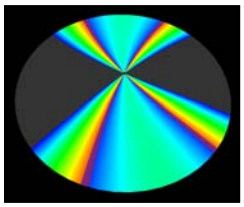
Mike Bailey
mjb@cs.oregonstate.edu





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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

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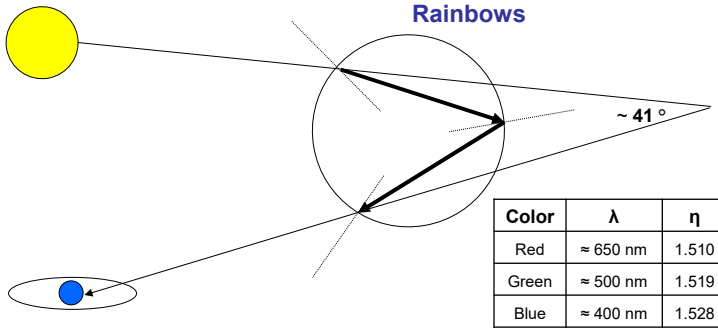
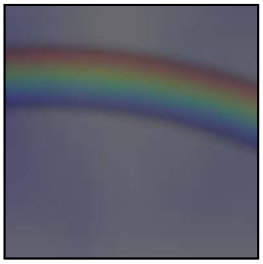
Rainbows



Primary Rainbow

Secondary Rainbow

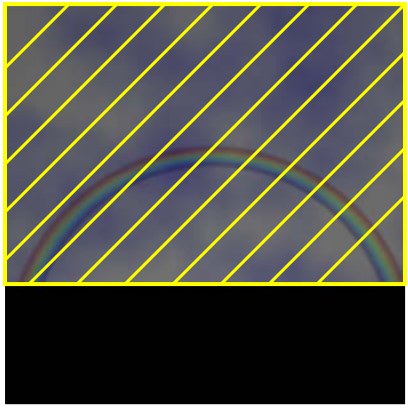
Color	λ	η	Θ	cosΘ	ΘΘ
Red	≈ 650 nm	1.510	42°	0.743	50.0°
Green	≈ 500 nm	1.519	41°	0.755	51.5°
Blue	≈ 400 nm	1.528	40°	0.766	53.0°



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 ≤ cos(Θ) ≤ .7700, paint a color
3. Otherwise, discard.



Spectral Colors

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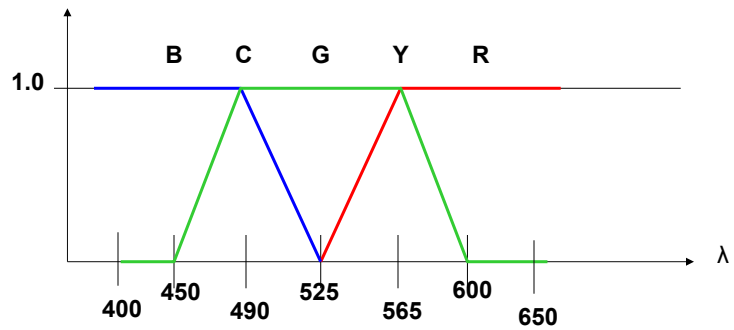


```
float
Pulse( float min, float max, float tol, float t )
{
   float a = min - tol;
   float b = min + tol;

   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 );
```

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Spectral Colors

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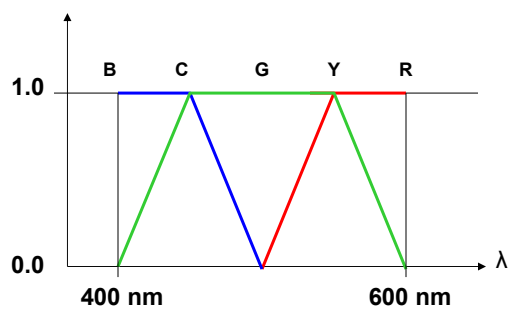


```
float t = ( λ – 400. ) / ( 600. – 400. );
vec3 rgb = Rainbow( t );
```

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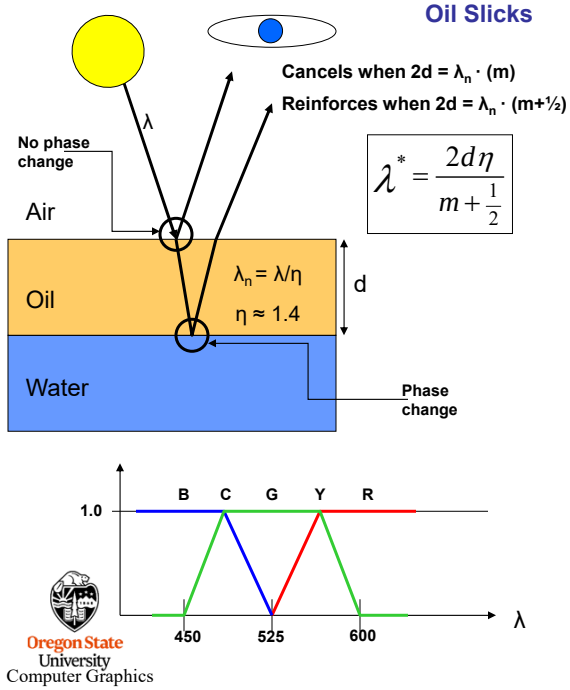
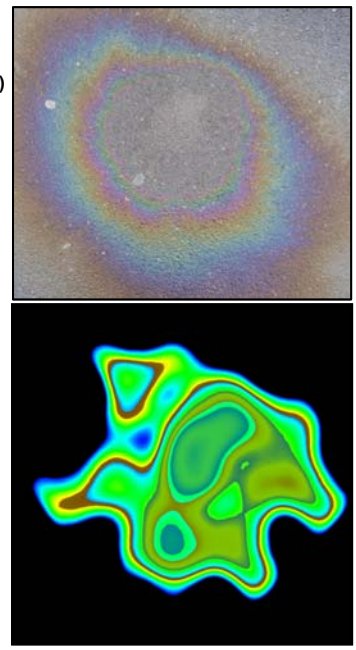
Oil Slicks



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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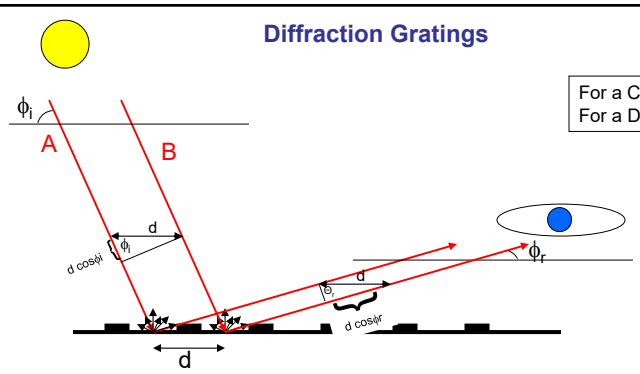
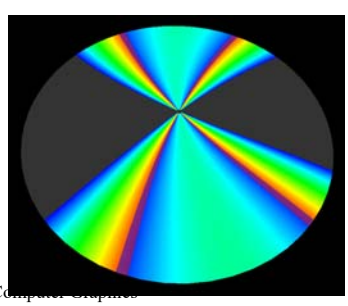
Diffraction Gratings



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



On the way in, Ray A travels $d\cos(\phi_i)$ *less* than Ray B. On the way out, Ray A travels $d\cos(\phi_r)$ *more* than Ray B.

So, wavelengths reinforce when $\text{abs}[\, d\cos(\phi_i) - d\cos(\phi_r)\,]$ is a multiple of the wavelength = $m\lambda$

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

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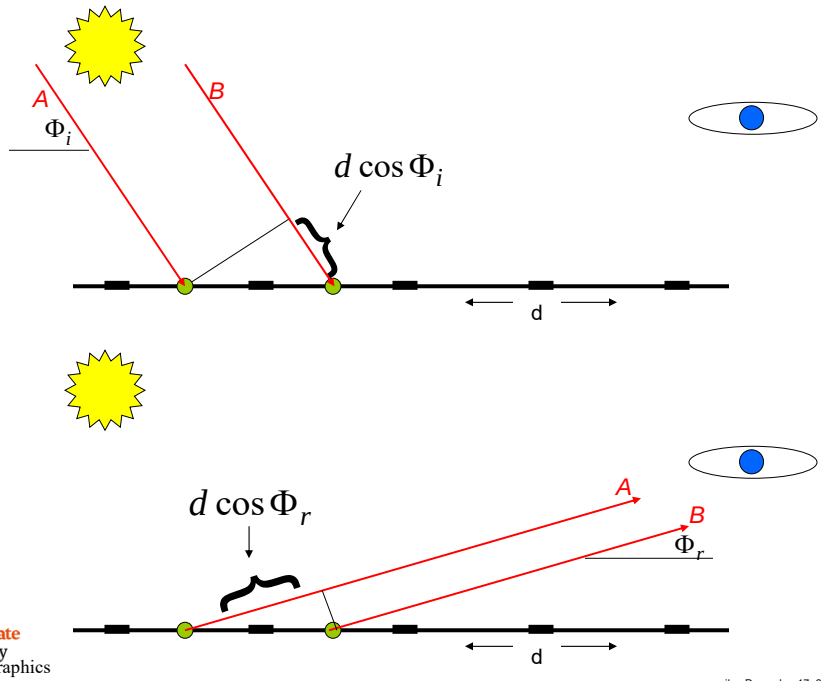

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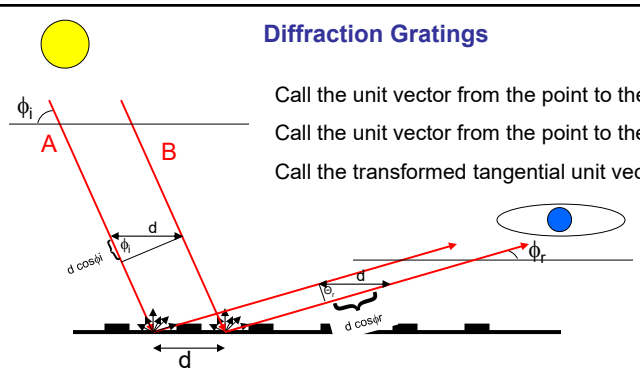
Diffraction Gratings



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

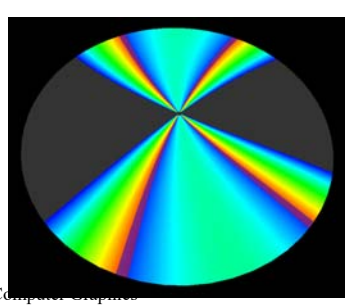
Call the unit vector from the point to the eye **ToEye.**

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)*



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

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