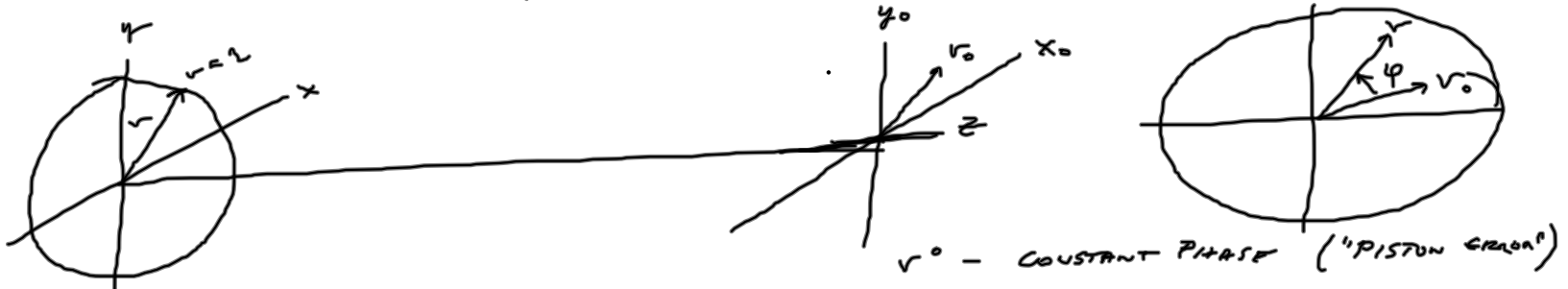


1/6/2010 MIDTERM EXAM 1/20/10 (W)

ABERRATIONS — DEVIATIONS OF WAVEFRONT EMERGING FROM XP RELATIVE TO IDEAL SPHERICAL WAVE



ΔW — WAVEFRONT ERROR

r^0 — CONSTANT PHASE ("PISTON ERROR")

~~2ND ORDER~~ $r^2 \rightarrow r_0^2$ 2ND ORDER

$r_0^2 \rightarrow$ PISTON ERROR

$r_0 r \rightarrow$ TIP TILT

$r^2 \rightarrow$ DEFOCUS

1/6/10 (2)

4th-order Terms
(3rd-order)

$$r_0^4 r_0^2 \cos^m \phi$$

$r^4 r_0^0 \cos^0 \phi \rightarrow$ QUARTIC PHASE AT PUPIL

SPHERICAL ABERRATION

W_{040}



W_{131} $r^3 r_0^1 \cos^1 \phi$ — DISTORTION

W_{222} $r^2 r_0^2 \cos^2 \phi$ W_{222} — ASTIGMATISM

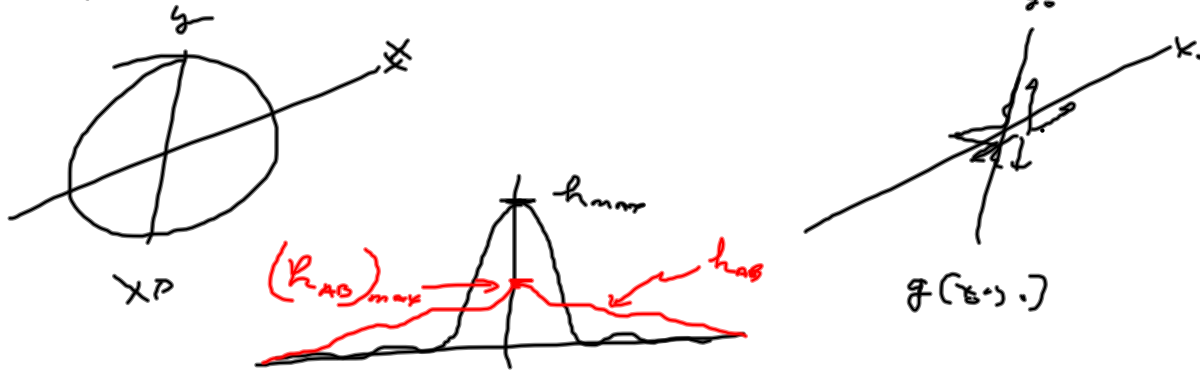
W_{220} $r^2 r_0^2$ CURVATURE FIELD

W_{131} $r^3 r_0^1 \cos \phi$ COMA

METRICS OF IMAGE QUALITY

1/2/10 - ⑤

(1) STREHL RATIO



$$\frac{(h_{AS})_{max}}{(h_{uv})_{max}} = \text{STREHL ABERRATION} - 0 \leq \mathcal{D} \leq 1$$

$$\mathcal{D} \approx 0.8$$

1/6/10 - (4)

PSYCHOLOGICALLY $\mathcal{D} = 0.8 \iff \mathcal{D} = 1.0$

WHAT $\Delta W \Rightarrow \mathcal{D} = 0.8$?

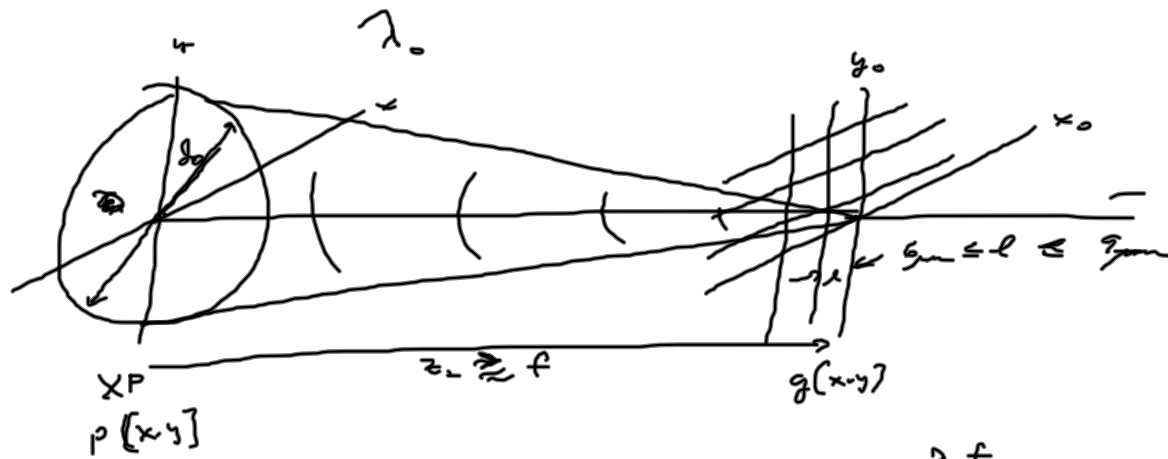
- (1) "AVERAGE" WAVEFRONT ERROR ACROSS PUPIL $\leq \frac{\lambda_0}{14}$
 $\Rightarrow \mathcal{D} \geq 0.8$ IF $\sigma_{\Delta W} \leq \frac{\lambda_0}{14}$ MARSHALL'S METRIC
- (2) "PEAK" WAVEFRONT ERROR AT PUPIL $\leq \frac{\lambda_0}{4} \Rightarrow \mathcal{D} \geq 0.8$



IF $\Delta W_{\max} \leq \frac{\lambda_0}{4} \Rightarrow$ WHICH ABERRATION IS DOMINANT
DOES NOT MATTER

RAYLEIGH'S QUARTER-WAVE RULE

1/6/10 - 5



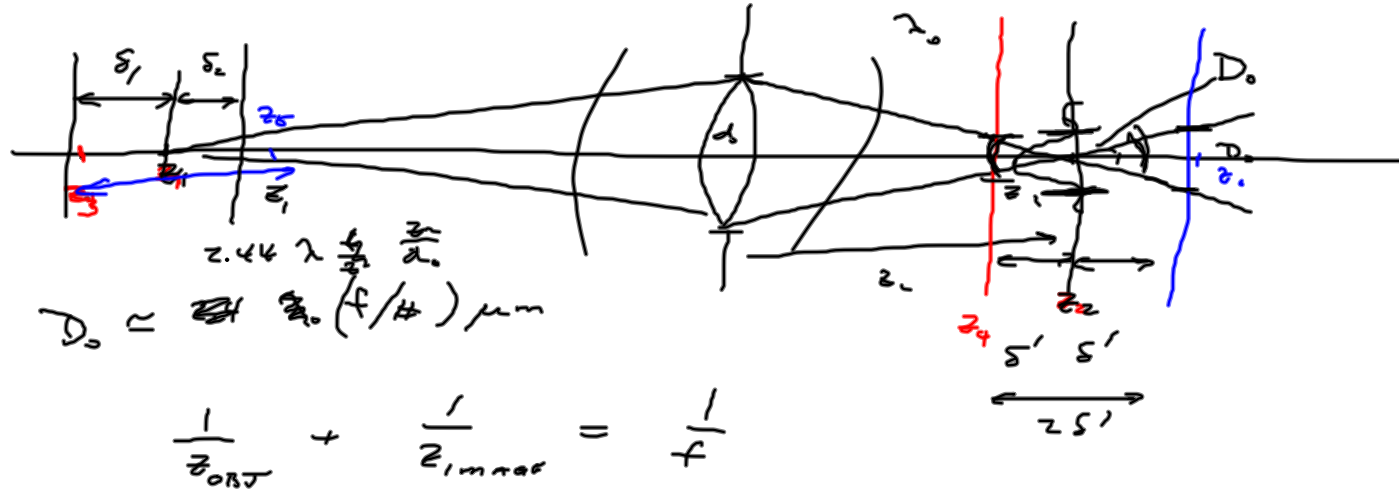
diameter of Airy disk $2.44 \frac{\lambda_0 f}{d_0} = 2.44 \lambda_0 \left(\frac{f}{d_0}\right) = D_0$

IN VISIBLE LIGHT $2.44 \lambda_0 \approx 1 \mu\text{m}$

f/p SYSTEM $\Rightarrow D_0 \approx 8 \mu\text{m}$

DEPTH OF FOCUS OR DEPTH OF FIELD
 (IMAGE SPACE) (OBJECT SPACE)

1/6/10 - ②



1/6/10 - ①

