# ON THE RESOLVING POWER OF COMPOUND FABRY-PEROT ETALON

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**ABSTRACT.** The authors have calculated the resolving power of compound Fabry-perot etalon on both Rayleigh and Abbe criteria, taking into account the contribution of the tails of the individual intensity patterns of the two lines to the maxima of resultant intensity pattern

## INTRODUCTION

Meissner (1942), in his calculation of the resolving power of the compound Fabry-Perot etalon on the Rayleigh criterion has neglected the contribution of the tails of individual intensity patterns of the two components to the central maxima of the resultant intensity pattern. Taking this into account the authors have calculated the resolving power of compound Fabry etalon on Rayleigh as well as Abbe criterion in this communication.

## INTENSITY CONSIDERATIONS

Consider two etalons of lengths $D'$ and $D''$ where $D' = pD''$ and $p$ is an integer. The intensities due to the two etalons separately at a point whose order in the longer etalon is $n_0 + n$, and the smaller one $(n_0/p) + (n/p)$, where $n_0/p$ is an integer and $n$ is small, is given by

$$I_1' = \frac{I_0'}{1 + F' \sin^2 \pi(n_0 + n)} = \frac{I_0'}{1 + x^2}$$

$$I''_1 = \frac{I''_0}{1 + F'' \sin^2 \pi(n_0 + n - \Delta n)/p} = \frac{I''_0}{1 + bx^2}$$

where $x = \pi F'^{\frac{1}{2}} n$ and $b = F''/4F'p^2$.

The intensity distribution due to the two etalons in tandem (Meissner 1942) is

$$I_1 = I_0/(1 + x^2)(1 + bx^2) \qquad \ldots \quad (1)$$

The intensity distribution of another line, separated by an order $\Delta n$ is given by

$$I_2 = I_0/\{1+(x-a)^2\}\{1+b(x-a)^2\} \quad \ldots \quad (2)$$

Hence the resultant intensity pattern is given by

$$\frac{I}{I_0} = \frac{I_1+I_2}{I_0} = \frac{1}{(1+x^2)(1+bx^2)} + \frac{1}{\{1+(x-a)^2\}\{1+b(x-a)^2\}} \quad \ldots \quad (3)$$

Neglecting shrinkage effect of close components the intensity maxima ($x \approx 0$ or $a$) and minimum ($x = a/2$) are given by

$$\frac{I_{max}}{I_0} = 1 + 1/\{(1+a^2)(1+ba^2)\} \quad (4)$$

and

$$\frac{I_{min}}{I_0} = 2/\{(1+a^2/4)(1+ba^2/4)\} \quad (5)$$

CALCULATION OF RESOLVING POWER

For limiting resolution

$$I_{min} = cI_{max} \quad (6)$$

where $c = 0.8$ and $0.981$ for Rayleigh and Abbe criteria respectively.

The resolving power is given by

$$\frac{\lambda}{d\lambda} = \frac{n_0}{\Delta n} = \frac{\pi}{a} n_0 F'^{\frac{1}{2}} = \alpha n_0 F'^{\frac{1}{2}} \quad (7)$$

In his solution of Eqn. (6) for $c = 0.8$, Meissner has neglected the term $1/(1+a^2)(1+ba^2)$ and he finally obtains

$$\alpha = \frac{\pi}{\sqrt{12}} \left\{1 + b + \sqrt{1+8b+b^2}\right\}^{\frac{1}{2}} \quad \ldots \quad (8)$$

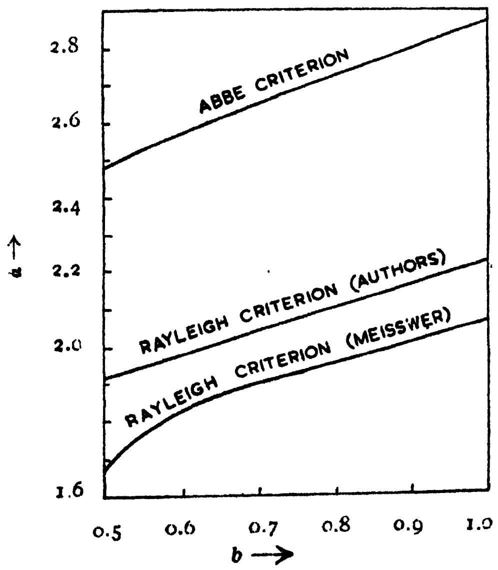


Fig. 1 Variation of $\alpha$ with $b$

The authors have solved Eqn. (6) for particular values of $b$ (1.0, 0.9, 0.8, 0.7, 0.6 and 0.5) and $c=0.8$ and 0.981 by the method of successive approximations. The high accuracy of the results obtained is evident from Tables I and II, which give the variation of $\alpha$ with $b$ according to Rayleigh and Abbe criteria respectively. Table I also includes values of $\alpha$ calculated by Eqn. (6) due to Meissner, for comparison. The tables are illustrated by figure 1.

TABLE I

Variation of $\alpha$ with $b$ on the Rayleigh criterion.

| $b$ | $a^2$ | $I_{max}$ | $I_{min}$ | $I_{min}/I_{max}$ | $\alpha$ (authors) | $\alpha$ (Meissner) |
|---|---|---|---|---|---|---|
| 1.0 | 2.0 | 10/9 | 8/9 | 0.8020 | 2.222 | 2.061 |
| 0.9 | 2.12 | 1.1066 | 0.8850 | 0.7998 | 2.159 | 2.009 |
| 0.8 | 2.24 | 1.1055 | 0.8854 | 0.8009 | 2.100 | 1.954 |
| 0.7 | 2.36 | 1.1122 | 0.8904 | 0.8003 | 2.046 | 1.895 |
| 0.6 | 2.52 | 1.1131 | 0.8924 | 0.7999 | 1.980 | 1.833 |
| 0.5 | 2.70 | 1.1150 | 0.8925 | 0.8005 | 1.913 | 1.766 |

TABLE II

Variation of $\alpha$ with $b$ on the Abbe criterion.

| $b$ | $a^2$ | $I_{min}$ | $I_{max}$ | $I_{min}/I_{max}$ | $\alpha$ |
|---|---|---|---|---|---|
| 1.0 | 1.20 | 1.1834 | 1.2066 | 0.9807 | 2.869 |
| 0.9 | 1.26 | 1.1850 | 1.2073 | 0.9815 | 2.800 |
| 0.8 | 1.332 | 1.1848 | 1.2076 | 0.9811 | 2.724 |
| 0.7 | 1.41 | 1.1861 | 1.2088 | 0.9812 | 2.646 |
| 0.6 | 1.5 | 1.1874 | 1.2105 | 0.9809 | 2.566 |
| 0.5 | 1.6 | 1.1905 | 1.2137 | 0.9809 | 2.484 |


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## REFERENCE


Meissner, (1942), *Jour. Opt. Soc. Amer.*, **32**, 185.