REFLECTANCE AND TRANSMITTANCE IN LINEAR FABRY-PEROT INTERFEROMETER IN CASE OF DIELECTRIC MEDIUM AND OBLIQUE INCIDENCE

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Two French physicists (Alfred Perot and Charles Fabry) developed the classical Fabry–Perot interferometer (FPI) or etalon at the beginning of the twentieth century. This novel form of interference device was based on multiple reflections of waves between two closely spaced and highly reflecting mirrors (the original thinly silvered plane glass mirrors were adjusted to be as flat and parallel to each other as possible). Alternative but conceptually equivalent elements are the "solid" etalon made from some low-loss materials (e.g., fused quartz or sapphire) or the Fabry-Perot (FP) cavity whose reflectors are partially transparent metal mirrors (e.g., perforated plates) or multilayer dielectric coatings (e.g., Bragg mirrors). The general concepts and theoretical analysis of these resonant optical cavities were published about the middle of the nineteenth century. Plane-parallel FPhave sharp resonances or transmission passbands at discrete frequencies. They thus behave as narrowband frequency filters. Their main characteristics (standing-wave resonance conditions, resonant frequencies, fringe contrast, free spectral range, half-power bandwidth, Q factor, reflectivity finesse) can be found in any general textbook dealing with optical resonators. Although approximate, this analytical treatment reveals itself very fruitful for the analysis of FP-based devices operating at microwave and millimeter-wave frequencies.

In their original form, FP used only flat reflecting surfaces, and the spacing between the mirrors was usually smaller than, or at most on the same scale as, the transverse diameters of the mirrors. Moreover, the FP interferometers were usually illuminated with a converging or diverging beam having a spread of angular directions, which resulted in "Fabry–Perot rings" transmitted through the interferometer in given discrete angular directions. Thus resonators are used as are spatial filters. In particular,the high directivity of FP-based resonator antennas originates from this property.

Since its invention, the FPI has continued to evolve and find many new fields of applications, ranging, for instance, from astronomy, astrophysics, atomic spectroscopy, optics, and similar applications to metrology, optical bistability, infrared, sensors, and plasma physics. A detailed and well-documented description of the FPI is at optical wavelengths. Here we concentrate only on infrared implementations