Appl. Phys. **B 70** (2000) 853-861

# Theory for the Spectral Transmittance of Christiansen Filters made of Glass Beads

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## Abstract

The spectral transmittance of Christiansen filters made of glass beads immersed in an index matching fluid is described theoretically based on geometrical optics. The glass beads and the immersion fluid are considered to be homogeneous and free of absorption. The diameter is assumed to be the same for all of the beads. Fresnel's reflection and prismatic deviation of the incident light are considered to be the dominant losses in transmission experiments. The parameters for these losses can be estimated a priori by a simple model. Losses by Rayleigh scattering and diffrac-tion can be included by additional parameters to fit the experimental spectral extinction curves. For the range of wavelength sufficiently far from the transmittance maximum the theoretical results of the model predict that the spectral extinction increases sublinearly with the thickness of the filters, the inverse of the diameter of the glass spheres, and the difference of the refractive indices between the glass and the immersion fluid. Due to the total reflection of the glass spheres, if their refractive index is smaller than that of the immersion, an asym-metry of the spectral transmittance curves is observed. Furthermore, the halfwidth of the spectral transmission passband decreases with increasing thickness of the filters and with decreasing average diameter of the grains for given dispersion curves of the refractive indices.

The simple theory to describe the spectral transmittance curves of Christiansen filters made of glass beads quantitatively seems to solve a 100 year old problem in physics.