THE ANOMALOUS EXTINCTION LAW

II. The Effect of Changing the Lower Size Cutoff of the Particle Size Distribution

H. STEENMAN

Academic Computing Services Amsterdam, Amsterdam, The Netherlands

and

P. S. THÉ

Astronomical Institute 'Anton Pannekoek', University of Amsterdam, Amsterdam, The Netherlands

(Received 13 November, 1990)

Abstract. In this paper we present further results of the calculation of anomalous extinction laws following Steenman and Thé (1989). The extinction laws in this article are calculated by enlarging the lower size cutoff of the particle size distribution, as opposed to the laws in the previous paper, which were obtained by making the upper size cutoff larger. The extinction laws we have derived have three important properties: (1) the change in the infrared is similar as in the case of changing the upper size cutoff; the difference increases as the value of \( R \) becomes larger, (2) in the ultraviolet the 2200 Å bump disappears gradually as the lower size cutoff is made larger, (3) in the far-UV the extinction curves become more and more flat. The ultraviolet extinction laws in the direction of the stars HD 200775 and HD 259431 are lower than the Savage and Mathis (1979) galactic interstellar extinction law.

1. Introduction

In Steenman and Thé (1989, hereafter referred to as Paper I) we have described the calculation of anomalous extinction laws by enlarging the upper size cutoff of the particle size distribution. These calculations are based on the Mie theorie for spherical particles. The extinction efficiency, derived by applying the Mie theorie, is integrated over the size distribution of the particles which results in an extinction cross-section as function of wavelength (Equations (1) and (2), Paper I). In above mentioned paper we have published the values of \( A_\lambda/A_v \) as function of effective wavelengths of currently used photometric systems.

Another result of our calculation in Paper I is, that, when the value of \( R = A_\lambda/E(B - V) \) is made larger the deviations of the extinction laws in the UV around the 2200 Å bump are relatively small. This is shown tridimensionally in Figure 1. In order to visualize how these deviations actually are, we plot in Figure 2 the values \([E(m_{0.22} - V)]_R - [E(m_{0.22} - V)]_{3.1}\) versus \( R \). We see that the differences first are positive, then approaching zero, and afterwards become positive again as \( R \) is made larger.

From observational studies of the extinction law of several Herbig Ae/Be stars in the spectral region from the UV to the IR, it was found that, when the value of \( R \) becomes larger than 3.1, the UV extinction law of these type of stars, around the 2200 Å bump becomes significantly flatter than that of the normal extinction law (Thé et al., 1981, Astrophysics and Space Science 184: 9–30, 1991. © 1991 Kluwer Academic Publishers. Printed in Belgium.)
In order to understand this behaviour we have tried to find out the effect of enlarging the lower size cutoff of the particle size distribution on the shape of the anomalous extinction curve. By doing this we in fact not only enlarged the average particle size, but, at the same time we also take away the influence of the very small particles (say about 0.01 μm) on the extinction law in the UV.

In the present paper we will show the results of the calculations of the extinction law when the lower size cutoff of the particle size distribution is enlarged from 0.005 μm