THE DETERMINATION OF PHYSICAL PARAMETERS FOR CIRCUMSTELLAR CLOUDS

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Abstract. The possibility of the detection of circumstellar clouds around hot stars have been shown based on the analysis of observed equivalent widths of resonance line 2852 Mg I of interstellar origin. An attempt has been made to combine two methods, earlier suggested - 'Method of Doublet 2800 Mg II' and 'Method of Depression' - for the determination of the parameters of circumstellar clouds. The sequence of the determination of these parameters is illustrated on the application of this combined method for circumstellar clouds around five hot stars. The value of the mean absorption coefficient \( k_0 \) for the system of resonance lines in the region of depression \( \sim 2400 \) \( \AA \), is obtained. An application of the conception of spectral classification of circumstellar clouds has been realized.

1. Statement of Problem

At present two methods can be proposed as a minimum for the detection of circumstellar clouds around hot stars. The first one, 'Method of Doublet 2800 Mg II', is based on the analysis of the absorption lines 2800 Mg II of interstellar origin; each line of this doublet, it turns out, represents itself the sum of two components, one of which forms in circumstellar cloud, while the second component is truly interstellar in origin (Gurzadyan, 1977, 1979). The second method, 'Method of Depression', detects the circumstellar cloud because of the vast depression in the continuous spectrum of the star, in the interval of 2200–2600 \( \AA \) and centered near 2400 \( \AA \) (Gurzadyan and Rustambekova, 1980). The region of this depression corresponds to the maximum number of resonance lines of neutral and ionized metals; the global effect – the depression or the falling-off of the continuous spectrum level arises by the absorption of a large number of nearby resonance lines.

With the aid of Mg II method, circumstellar clouds have been discovered around of 50 stars of O, B, A classes (Gurzadyan, 1981). The circumstellar clouds around approximately 30 stars have been discovered with the aid of the depression method (Rustambekova, 1976, 1980, 1983). Also, in both methods, an attempt has been made to determine the essential physical parameters – particularly, the dimensions of the cloud, the concentration and also the mass, based on the observational parameters – the equivalent width \( W_c(\text{Mg} \, \text{II}) \) of the doublet 2800 Mg II in the first case, and the magnitude of the depression \( D \) of continuous spectra near 2400 \( \AA \) in the second case.

However, it is necessary to note that the experimental means for the determination of both parameters \( W_c(\text{Mg} \, \text{II}) \) and \( D \), are quite different; for measurements of \( W_c(\text{Mg} \, \text{II}) \) it is necessary to have a spectrograph or spectrometer of very high spectral resolution (of the order of 0.1 \( \AA \)), while for the determination of \( D \) it is enough to have a spectrograph of moderate or even of low resolution (of the order of 10 \( \AA \)).
In this connection a question arises: could not both methods be united for the determination of the cloud's parameters by simultaneous use of both observational parameters \( W_c(MgII) \) and \( D \). Of course, it is possible in case when both types of observations in space conditions are carried out in relation to the given star. The aim of this paper is, particularly, to show the possibility of such a unification illustrating, as a result, the developed scheme in relation to few stars.

However, first of all we should like to discuss the possibility of the detection of circumstellar clouds by the help of another ultraviolet absorption line of neutral magnesium \( - 2852 \text{MgI} \).

### 2. Detection of Circumstellar Clouds with the Aid of the Absorption Line \( 2852 \text{MgI} \)

Until 1985 the absorption line \( 2852 \text{MgI} \) of interstellar origin was discovered and measured in the spectra of nearly 50 stars - they are collected in Table I with the following data: spectral class; distance \( r \); colour exceeds \( E(B - V) \) and equivalent width \( W(2852 \text{MgI}) \) (for references, see Gurzadyan, 1981; de Boer et al., 1986). It must be noted that the data for \( W(2852) \) collected from different sources are extremely unhomo-

geneous.

Let us examine the distribution of all these stars on the coordinate system of \( W(2852) \) and \( r \); as it was done on Figure 1. According to this figure, it is very difficult to note the existence of more or less clear relationship between \( W(2852) \) and the distance \( r \). The scatter of the observational points is very large and it cannot be explained completely by the dispersion in the absorption properties of interstellar clouds in different directions in the Galaxy. This fact itself shows that in all cases the interstellar lines \( 2852 \text{MgI} \) actually registered do not have altogether interstellar origin and that at least a source of absorption on the path from the star to the observer must exist. It is not difficult to see that it must be the circumstellar cloud around the examined star.

Indeed, it is not difficult to note the existence of a line in the relationship \( W(\text{MgI}) \sim r \), lower of which the observational points are absent, and this line corresponds to the interstellar component of the absorption with the amount of \( \Delta W(\text{MgI}) = 0.1 \text{ Å kpc}^{-1} \). Of course, this is the minimum magnitude for the equivalent width of \( 2852 \text{MgI} \) of purely interstellar origin. However, in order to void contingency, we can draw a range of lines with progressively increased absorption corresponding to the values of \( \Delta W(\text{MgI}) \) equal to 0.2, 0.3, and 0.4 Å kpc\(^{-1} \); in the last case, particularly, 30 stars from 47, that is \( \sim 65\% \), are located above the line \( W(\text{MgI}) = 0.4r \text{ Å} \), and, hence, these stars must possess in principle circumstellar clouds with the highest probability because the rest of the equivalent width in the amount of \( W_c(\text{MgI}) = W(\text{MgI}) - 0.4r \) cannot be explained in any way except even taking into account the anomalous cases of the interstellar absorption.

Formerly this method of separation of observed equivalent widths into two components was used for the discovery of circumstellar clouds with the aid of the doublet \( 2800 \text{MgII} \). Now we see that the absorption line \( 2852 \text{MgI} \) may also be used first of all