# POLARIZATION CHARACTERISTICS OF JENSCH COELOSTAT

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**Abstract.** The polarization characteristics of the Jensch coelostat, used at the Sayan observatory, are presented. Results of calculations of the instrumental polarization (IP) are compared with the observations. It is shown that structural features of the Jensch coelostat lead to a very important dependence of the Stokes's parameters, that characterize the IP, on solar coordinates.

## 1. Introduction

In order to interpret magnetographic measurements, it is necessary to know and take correctly into account polarization characteristics of the instrument. As far as solar observations are concerned, coelostat mirror reflections are the main factor responsible for an additional polarization of light, the so-called instrumental polarization (IP). Since polarization properties of different instruments are individual in character, there have been a large number of papers devoted to the IP. Analyses were made for the solar telescope in Oslo by Kjeldseth Moe (1968), for the Potsdam Observatory by Jäger (1972), the Okayama Observatory by Makita *et al.* (1982), the Crimea Observatory by Kotov (1973), the Kodaikanal Observatory by Balasubramaniam, Venkatakrishnan, and Bhattacharrya (1985), the Arcetri Observatory by Capitani *et al.* (1989), etc.

This paper makes an attempt to investigate the IP of the Sayan Observatory STOP telescope (see Grigoryev *et al.*, 1981; Grigoryev and Demidov, 1987) that uses a Jensch coelostat (Jensch, 1959). The results discussed in this study will be useful not only for STOP, but also for other observatories.

Unlike 'classical' coelostats, the mirrors in the Jensch coelostat (see Figure 1) are installed on a single mounting, which makes it sufficiently compact, but both the declination mirror and the hour angle mirror rotate with different velocities. Depending on the solar hour angle, the declination mirror is usually reversed in the eastern or western position with respect to the rotation lever.

In this paper the problem of determining optical constants of mirrors (refractive index $n$ and absorption factor $k$) has been solved by a programmed choice of values of these parameters which satisfy the best suitably conducted IP measurements. The observational data are best satisfied by $n = 1.21$ and $k = 6.08$, and these quantities were used in the calculations.

## 2. Results and Discussion

Figure 2 shows the variation, as a function of the hour angle of (a) the degree of polarization $P$ and (b) the azimuth of linear polarization $A$. The calculations have been

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Fig. 1. A general scheme of the STOP telescope Jensch coelostat of the Sayan Observatory. Arches supporting the polarization attachment input-output mechanism are positioned at the sunward end of the rotation lever.

made for different values of the declination $\delta_\odot$. One can see that the minimum degree of polarization is about 2.5%. The variation of $P$ during the day is quite considerable, up to 0.8% per hour. Time variations in azimuth is also quite high, and this is substantially larger than the value reported for 'classical' coelostats (Kotov, 1973). The contribution to the total polarization of light from each of the Stokes's parameters is shown in Figure 3 ((a) for the $Q$ parameter, (b) for the $U$ parameter, and (c) for the $V$ parameter). Inspection of Figure 3(a) reveals that the $Q$ parameter shows quite a considerable dependence on $\delta_\odot$: the difference ranges from $-1.8\%$ for $\delta_\odot = +23°$ to $-5.3\%$ for $\delta_\odot = -23°$. The time behaviour of the $U$ parameter, however (Figure 3(b)), has a much more monotonic character. As far as the circular polarization is concerned,

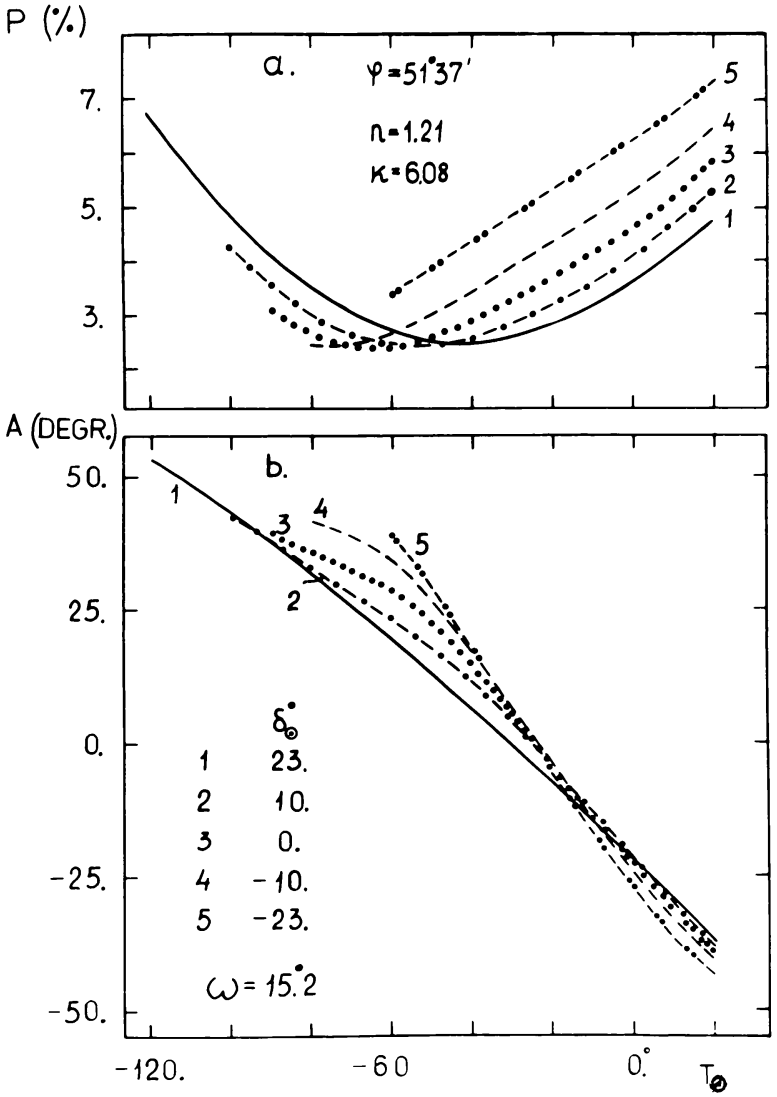


Fig. 2. The degree of polarization (a) and azimuth of linear polarization (b) as a function of the hour angle. The calculations have been made for different declinations $\delta_\odot$, under the assumption that the Jensch coelostat is illuminated by natural light.

an examination of Figure 3(c) reveals that it is relatively small for solar declinations $\delta_\odot > 0°$. A characteristic property of all curves in Figure 3(c) is that they have a parabolic character, which appears to be a convincing reason for the use of second-degree polynomials when filtering trends in long-time sequences of magnetograph observations (Demidov, Kotov, and Grigoryev, 1990).

Thus, the results presented above indicate that the polarization properties of Jensch coelostats differ substantially from those of 'classical' coelostats. Further, it would be appropriate to say that, in order to verify the dependence of the results obtained on parameters involved in the calculations such as $n$ and $k$, the tilt of the declination mirror to the declination axis $w$ and latitude $\varphi$, special calculations were performed using altered values of these parameters. It appears that a variation, within a certain range, of $n$, $k$, and $w$ has a minor effect on polarization characteristics of Jensch coelostats.

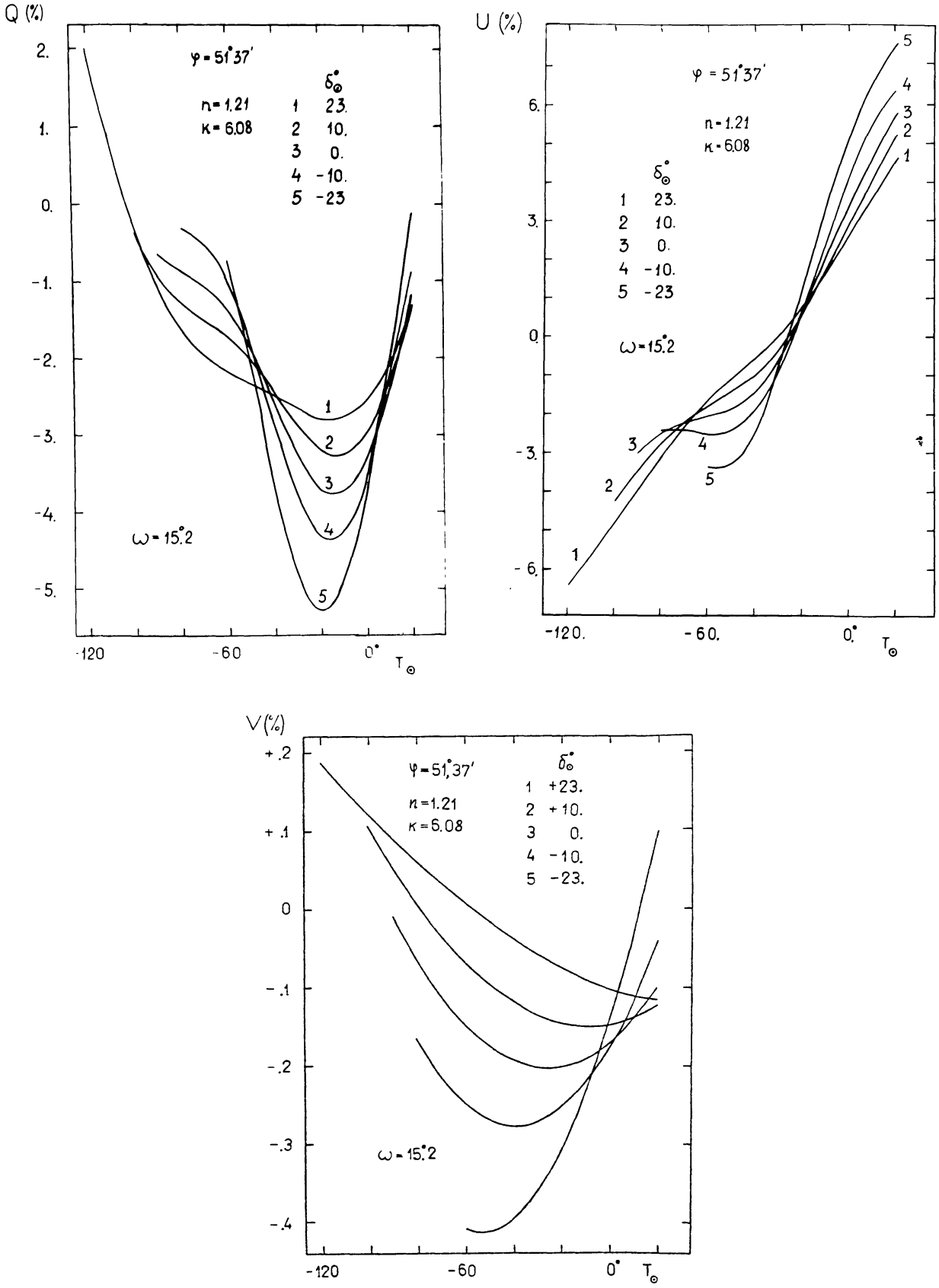


Fig. 3. The time variation of the Stokes's parameters describing the polarization of natural light after traversing the Jensch coelostat: (a) $Q$ parameter; (b) $U$ parameter; and (c) $V$ parameters. The Stokes's parameters are all normalized to the brightness and are expressed in percent.

On the whole, it is possible to conclude that the results are of interest within the context of relevant techniques and may be useful for solving some problems arising when interpreting observations.

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