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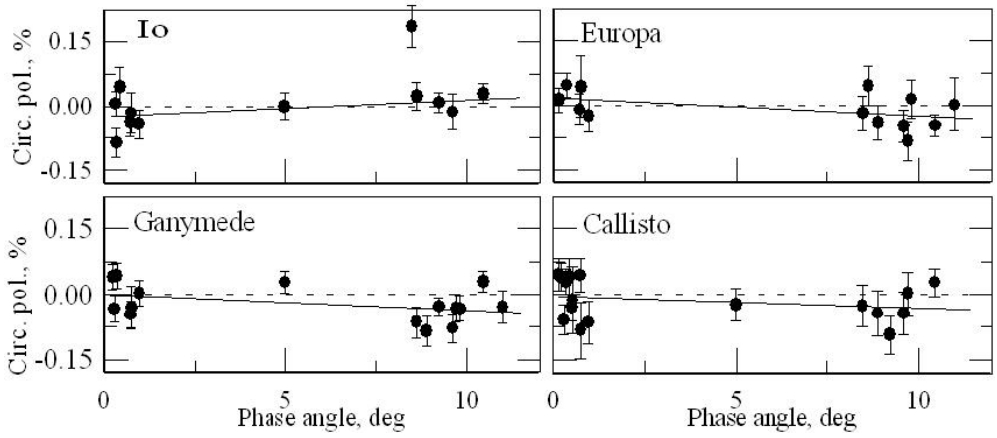
CIRCULAR POLARIZATION OF GALILEAN SATELLITES OF JUPITER

Круговая поляризация галилеевых спутников Юпитера

Abstract. Представлены результаты наблюдений круговой поляризации галилеевых спутников Юпитера. Наблюдения выполнены при оппозициях Юпитера в 2005, 2007–2009 и 2011 гг. в диапазоне фазового угла $\alpha = 0\overset{\circ}{.}14 - 11\overset{\circ}{.}0$. Получены средние фазовые зависимости круговой поляризации для Ио, Европы, Ганимеда и Каллисто в стандартной спектральной полосе V, показывающие линейное изменение поляризации с углом фазы.

Polarimetric studies of the Galilean satellites showed that these objects differ in terms of their surface microtexture and albedo (Mishchenko M. et al., Polarimetric Remote Sensing of Solar System Objects. Akademperiodyka, Kyiv, 2010). However, this pertains to observations of linear polarization. Circular polarization was absolutely deprived of observers' attention.

Our polarimetry was carried out with the 0.7-m reflector of the Institute of Astronomy of the Kharkiv Karazin National University and 1.0-m reflector of the Crimean Astrophysical Observatory (Simeiz). Both telescopes were equipped with a single-channel photoelectric polarimeter with a V filter of the Johnson–Morgan system. A fast-rotating quarter wavelength achromatic retarded plate with a polaroid was used as an analyser (Velichko S. Ph.D. thesis, MAO, Kyiv, 2010). Measurements of the circular polarization of Io, Europa, Ganymede and Callisto were obtained in April 2005, June 2007, July 2008, June–July and August 2009, August–November 2011, and are presented in the Figure.



Composite phase-angle dependency of circular polarization in the V band for Io, Europa, Ganymede and Callisto. The solid line is a linear fit to the observed data.

The polarimetric observations were made at a phase angle of the satellites ranging from 0°.14 to 11°.0. It has given us a possibility to compose phase-angle dependences of circular polarization for Galilean satellites (see Figure) in the entire range of phase angles accessible to ground-based observations. The accuracy of the measurements of circular polarization is on the average 0.04%. The obtained data were approximated by a linear function. The slope parameter ε_v of the linear function turned out to be small and for all four satellites it is about 0.4% per 100° of phase angle. The Table lists the values of ε_v and σ_ε (accuracy of its determination) for our observations of the Galilean satellites together with the composite dependence for comets, theoretical calculation for optical active particles OAP (Rosenbush V. et al., Proc. 10th ELS, Bodrum, Turkey, 2007, 181) and a mixture of needlelike small oriented particles with spherical ones (Beskrovnaja N. et. al., ESA SP-278, 1987, 681).

Table: Slope of phase-angle dependence of circular polarization

Object	Phase angle range (deg)	ε_v (10^{-2} per degree)	$\pm\sigma_\varepsilon$ (10^{-2} per degree)
Io	0.32-10.46	+0.4	0.3
Europa	0.14-11.00	-0.4	0.2
Ganymede	0.22-11.00	-0.4	0.2
Callisto	0.14-10.46	-0.3	0.3
Comets	23-122	-0.3	0.1
OAP	0-120	-0.1	-
mixture	0-70	±1.2	-

As one can see from the Table, the satellites Europa and Ganymede have ε_v that exceeds twice σ_ε, and they are comparable to the value of σ_ε for Io and Callisto. While the trend of phase-angle dependency is approximately the same for the satellites Europa, Ganymede and Callisto, the trend for Io with the available data set is formally opposite. It is interesting to note that the results of the observations of the satellites and comets as well as theoretical calculations for the mixture and OAP are in a good qualitative agreement. The absolute value of the left-hand circular polarization shows a systematic trend with phase angle. Moreover, the phase dependences of the satellites and cometary dust have similar parameters.

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