Polarization of the Daytime Sky

Y. Zinkova\textsuperscript{1}, Ts. Tsvetkov\textsuperscript{1}, R. Zlatev\textsuperscript{2}, N. Petrov\textsuperscript{1}

\textsuperscript{1} Institute of Astronomy and NAO, Bulgarian Academy of Sciences

\textsuperscript{2} Independent researcher
Motivation

- Observations of total solar eclipses in polarized light
- Evolution of observational instruments
  - Analog camera and linear polarization filter – up to 2006 incl.
  - Polarization camera – for future observations
- The need to check the new method

History of observations

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.08.1999</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>29.03.2006</td>
<td>Turkey</td>
</tr>
<tr>
<td>22.07.2009</td>
<td>China</td>
</tr>
<tr>
<td>21.08.2017</td>
<td>USA</td>
</tr>
<tr>
<td>02.07.2019</td>
<td>Chile</td>
</tr>
<tr>
<td>14.12.2020</td>
<td>Argentina</td>
</tr>
<tr>
<td>23.04.2023</td>
<td>Australia</td>
</tr>
</tbody>
</table>

White-light corona photographed during total solar eclipse in Turkey, 2006
Essential tasks during the observations of total solar eclipses:

- Observations of polarized light from the white-light corona
- Determination of the degree of linear polarization of active regions
- Dependencies between the degree of linear polarization and electron density of the K-corona
- Dependencies between the latitude of the Sun and the degree of linear polarization
Degree of linear polarization of solar corona

Polarized corona photographed during total solar eclipse in Turkey, 2006

Results for degree of polarization
Total solar eclipse in Turkey, 2006
Positions of singular polarization points in the solar corona during the total solar eclipse, 2006.

Dependence of the position of singular polarization points on altitude of the Sun during observations from three locations shown on previous picture.
New polarization camera

SVS-Vistek
exo253ZGE Polarized

Technical characteristics:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution [MP]</td>
<td>12.3 MP</td>
</tr>
<tr>
<td>Resolution (h x v)</td>
<td>4096 x 3000 px</td>
</tr>
<tr>
<td>Frame rate (max.)</td>
<td>10 fps</td>
</tr>
<tr>
<td>Chroma</td>
<td>mono polarized</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>Sony</td>
</tr>
<tr>
<td>Sensor type</td>
<td>Area CMOS</td>
</tr>
<tr>
<td>Sensor size (h x v)</td>
<td>14.13 x 10.35 mm</td>
</tr>
<tr>
<td>Pixel size (h x v)</td>
<td>3.45 x 3.45 µm</td>
</tr>
<tr>
<td>Exposure time (min)</td>
<td>28 µs</td>
</tr>
<tr>
<td>Exposure time (max)</td>
<td>1 sec (external ∞)</td>
</tr>
<tr>
<td>Dimensions (w x h x d)</td>
<td>50 x 50 x 43 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>140 g</td>
</tr>
<tr>
<td>Operating temperature (housing)</td>
<td>-10 to 60 °C</td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>10 to 90 % (non-condensing)</td>
</tr>
</tbody>
</table>
Experimental setup

- Polarization camera exo253ZGE + 70 mm lens
- Polarization camera exo253ZGE + 200 mm lens
Daytime sky polarization

On 70 mm:

Raw picture of daytime sky polarization

Representation of the polarization angle using the data from the camera

Representation of the degree of polarization using the data from the camera

Total results for degree of polarization for all 35 images taken in period of 6 hours on 19.08.2022 from NAO Rozhen
On 200 mm:

- Raw picture of daytime sky polarization
- Representation of the polarization angle using the data from the camera
- Representation of the degree of polarization using the data from the camera

Total results for degree of polarization for all 33 images taken in period of 6 hours on 19.08.2022 from NAO Rozhen
Full moon polarization

Raw picture of the full moon

Representation of the degree of polarization using the data from the camera (first experimental scale)

Representation of the degree of polarization using the data from the camera (second experimental scale)
Representation of the degree of polarization using the data from the camera with three different lenses:

- 70 mm
- 200 mm
- 600 mm

Representation of the degree of polarization with different positions of the moon on the camera matrix:
Conclusions and open questions

• First results show that the new polarization camera can be used for photographing solar eclipses.
• Benefits of this method are: simultaneous observations at four different angles of polarization, time saving and error reducing.
• For polarized observations of solar eclipses, it is important to use lenses with longer focal length to reduce the influence of the position of the corona on the image.

• May the exposure influence the results for the degree of polarization?
• May the altitude influence the results for the degree of polarization?
• What will be the results if we use different narrowband filters? – next experiment with full moon observations
THANK YOU!

This research is funded by the National Science Fund of Bulgaria with contract No. KP-06-H28/4