

Solar eclipses as a chance for professional-amateur scientific collaboration

Yoichiro Hanaoka 

National Astronomical Observatory of Japan,
2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan
email: yoichiro.hanaoka@nao.ac.jp

Abstract. Total solar eclipses are popular targets for amateur astronomers. At the same time, the eclipses are still scientifically important to observe the solar corona. Therefore, the eclipses are a good chance for amateurs to participate in scientific observations. In fact, some of amateur astronomers in Japan have been carried out scientific observations at the total solar eclipses collaborating with professional solar scientists over more than ten years. Some scientific results have been produced from the collaboration. We present here our collaborative activities as a practical example of citizen science.

Keywords. solar eclipses, solar corona, citizen science

1. Advantages of the Pro-Ama collaboration in the eclipse observations

Energetic phenomena on the Sun, which occasionally affect the electromagnetic environment of the Earth, occur in the solar corona. Therefore, the solar corona is an important scientific target, and total solar eclipses enable us to observe the corona from just above the limb to several solar radii. That is one of the reasons why the solar eclipse observations are still carried out in the space age. However, only a snapshot of the corona can be observed from a site. Therefore, to track the evolution of the corona, multi-site observations of the solar eclipses are necessary, and they can be realized by amateur observers, who widely spread along the total eclipse path. Furthermore, the multi-site observations help to mitigate the risk of the weather conditions. Thus, the participation of amateurs in the scientific observations of solar eclipses is very valuable (for an extreme example, see [Peticolas et al. 2019](#)).

2. Scientific results produced by the Pro-Ama collaboration and more advanced observations

The professional and amateur collaboration for the observation of the solar eclipses in Japan, which has been continued for more than ten years, have really produced some scientific results ([Hanaoka et al. 2012](#); [Hanaoka et al. 2014](#); [Hanaoka et al. 2018](#)). Most of the cutting-edge astronomical observations require expensive, sophisticated instruments, but, on the contrary, imaging observations of the solar eclipses can be carried out with small telescopes. There are many amateur observers who take photos (white-light images) of the solar corona. Just an addition of the acquisition of calibration data (dark and flat-field) makes their photos scientifically valuable data; the above-mentioned results have been obtained with such observations. In the case of solar eclipse observations, amateur observers sacrifice nothing to participating citizen science; they can enjoy the eclipse as usual.

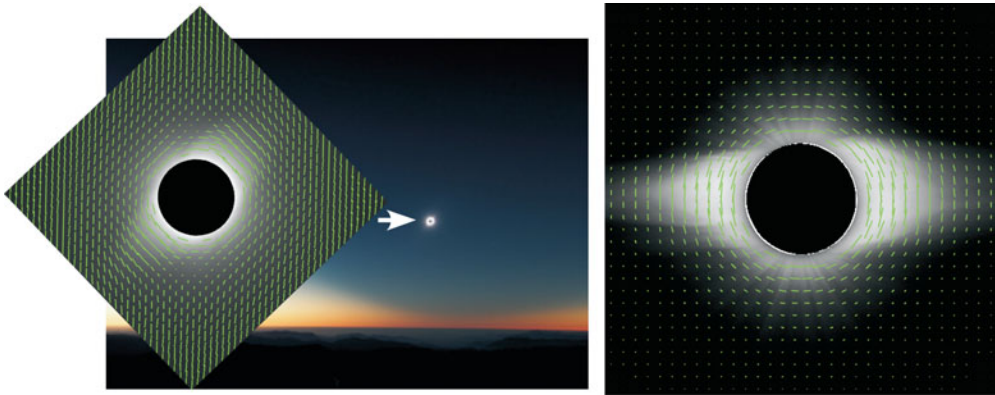


Figure 1. Images taken during the eclipse on July 2, 2019. Left: Raw polarization signals of the corona shown with green ticks and a wide-field view of the total eclipse. The zenith is to the top. The vertical components correspond to the polarization of the sky, which is remarkable at the low elevation (13 deg in this case). Left: Polarization data from which the sky components were removed.

Furthermore, some of amateur astronomers are eager to carry out more sophisticated observations. The polarimetry of the corona is a good target for them. The information of polarization is the key to distinguish the K-corona (hot plasma belonged to the Sun) and the F-corona (interplanetary dust). Some amateur astronomers, who are collaborating with us, started to the polarimetry observation of the eclipses from 2016. They successfully obtained the polarization data in the 2017 and 2019 eclipses as well. Figure 1 shows an example of the results of the polarimetry of the solar corona taken during the 2019 solar eclipse. It is not very easy to set up the polarimetry instrument or the observation procedure, but its accomplishment is more rewarding.

3. Conclusion

In this way, the solar eclipses are a good chance for the citizen science based on the professional-amateur collaboration involving a broad range of amateur astronomers. As Haklay (2013) discusses, data collection by amateurs accompanied by devising its method by themselves can be considered as a high-level participation of amateurs in citizen science.

Although we could not carry out coordinated observations at the eclipse in December 2020, we will continue to the eclipse observations including the polarimetry. Furthermore, international professional-amateur collaboration will be a course of action in future.

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