中国科学院云南天文台
YUNNAN OBSERVATORIES,CHINESE ACADEMY OF SCIENCES

第十屆海峽兩岸
天文望遠鏡與觀測前沿技術研討會

The Correction of the Scattered Light of An Inner-occulted Coronagraph

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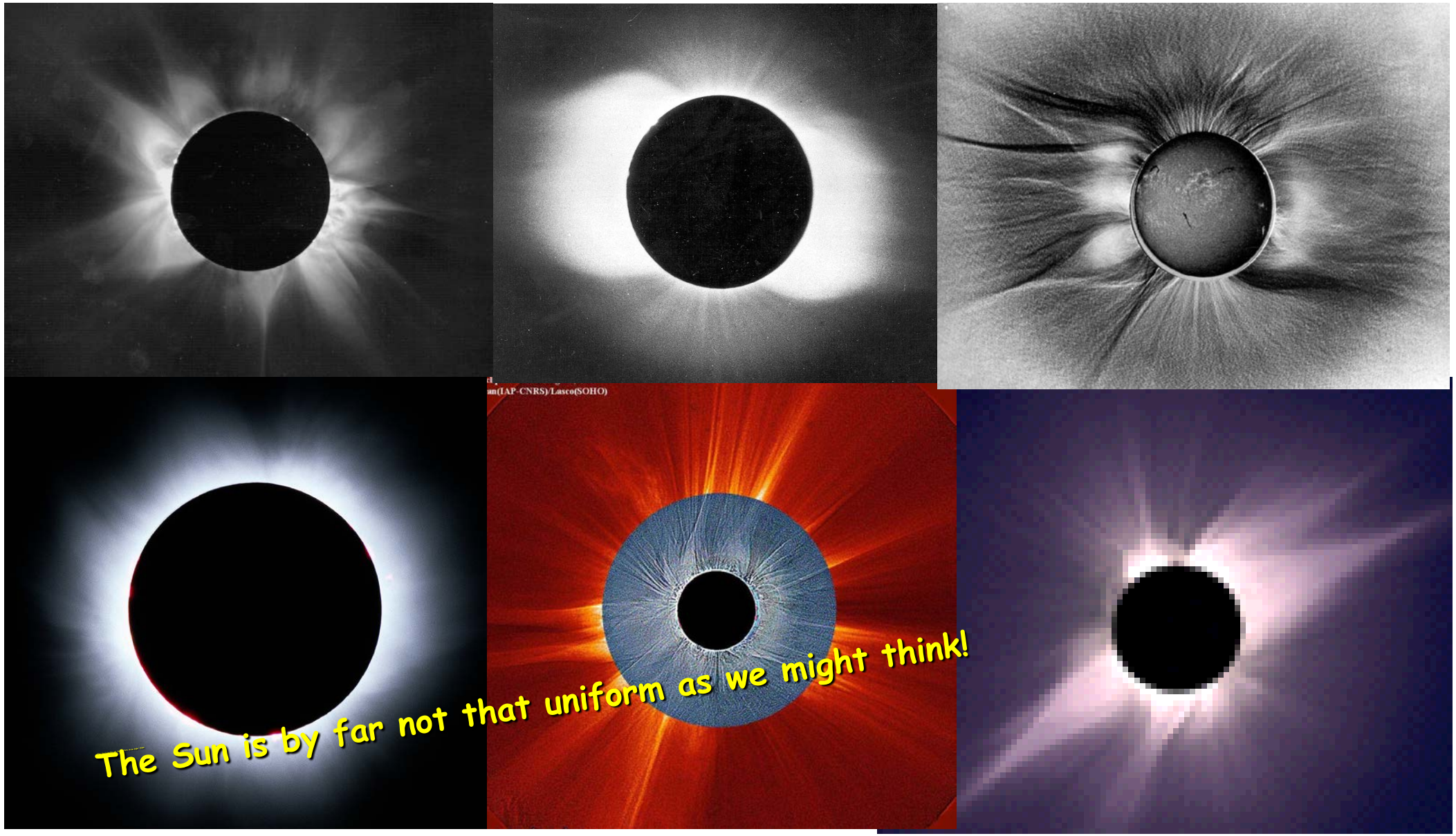
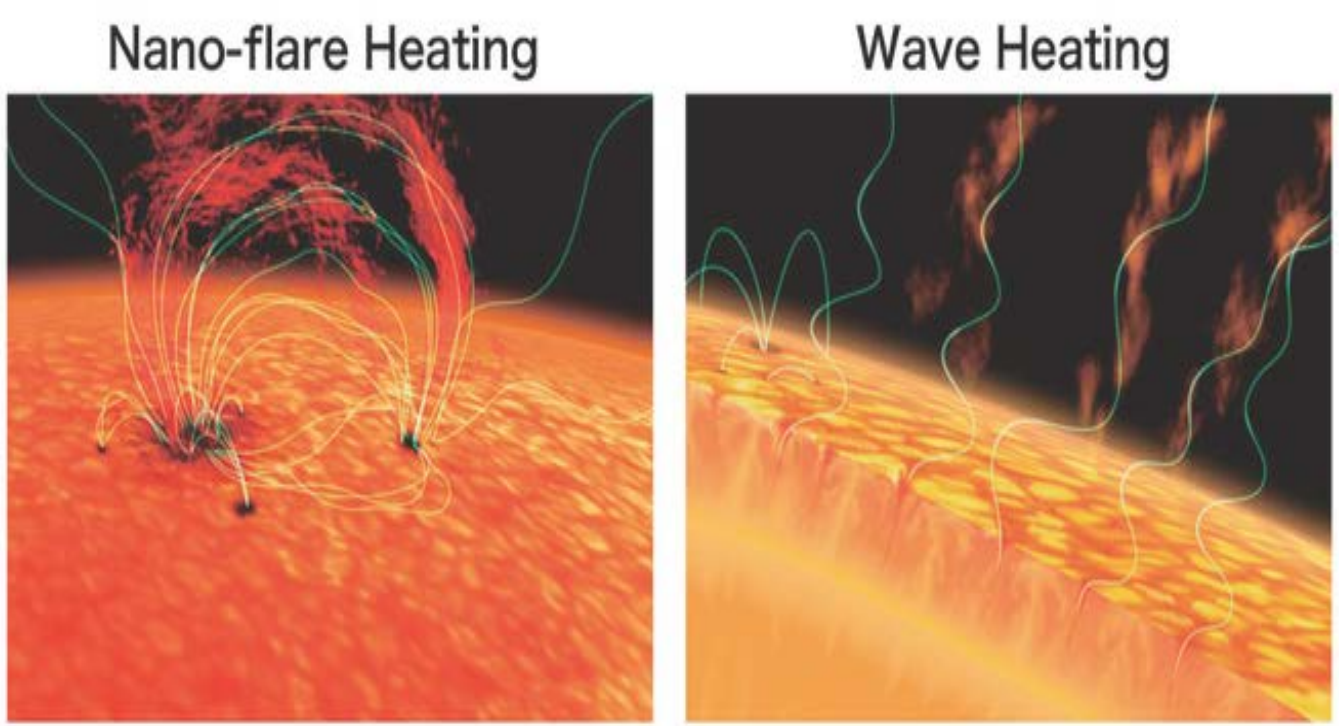
中国科学院云南天文台、西南交通大学、中国科学院国家天文台、山东大学(威海)

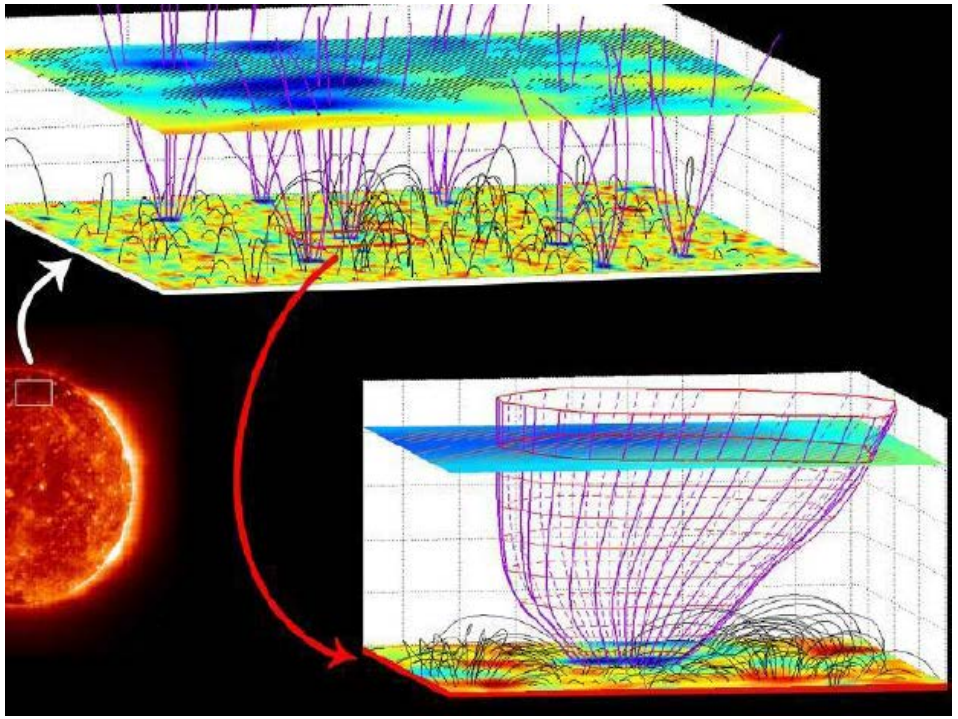
2023/11/23

Content

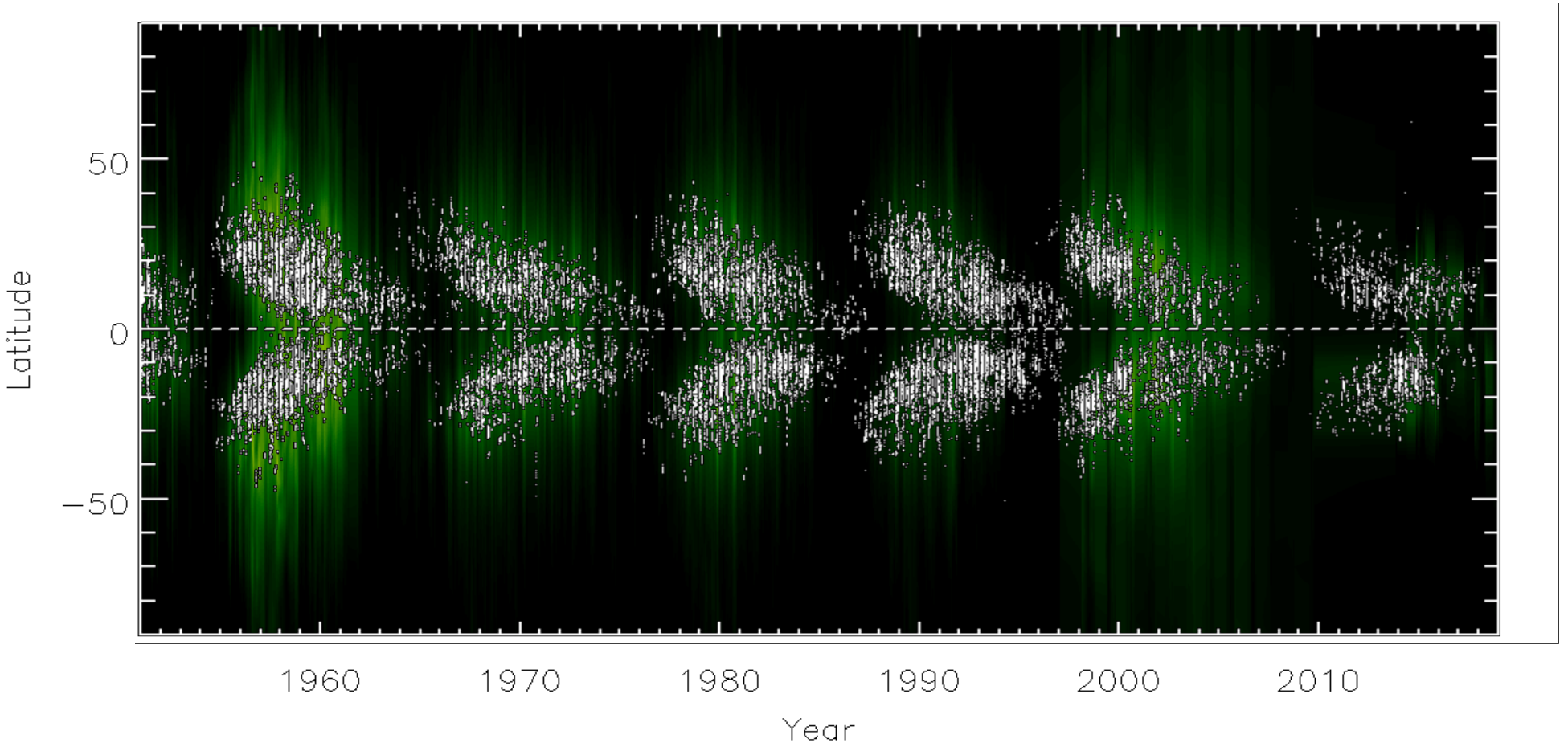

(IAP-CNRS)/Lasco(SOHO)
The Sun is by far not that uniform as we might think!



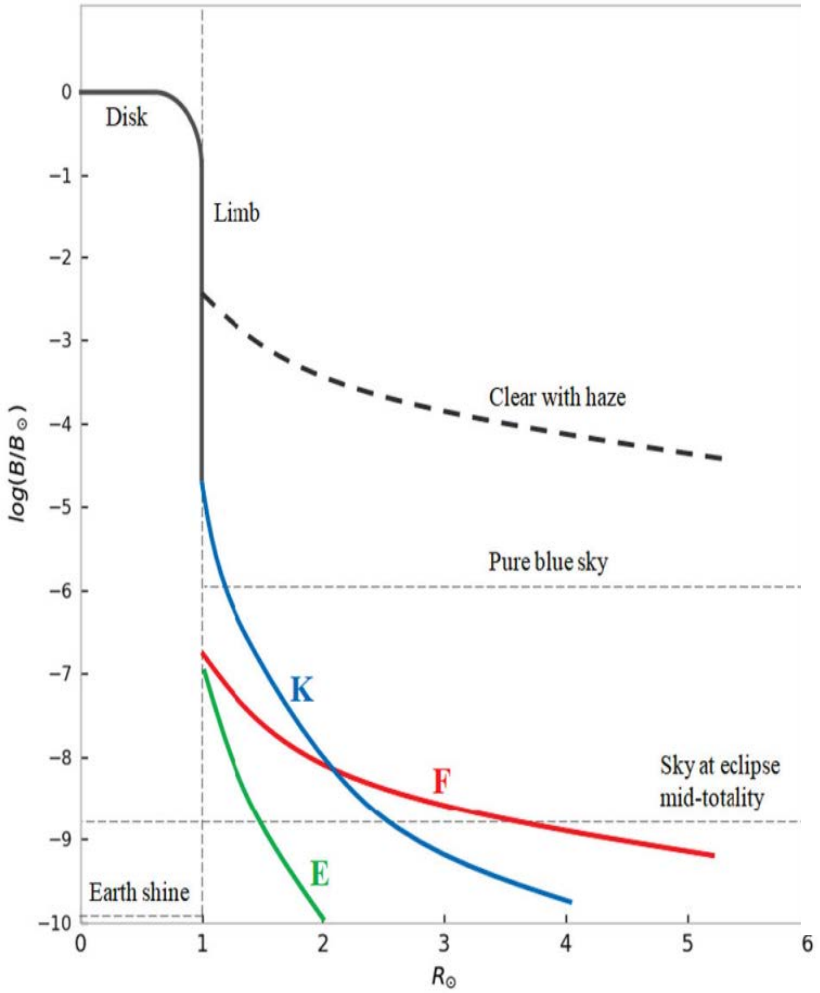
(Ryuichi,K.,et al., 2016)



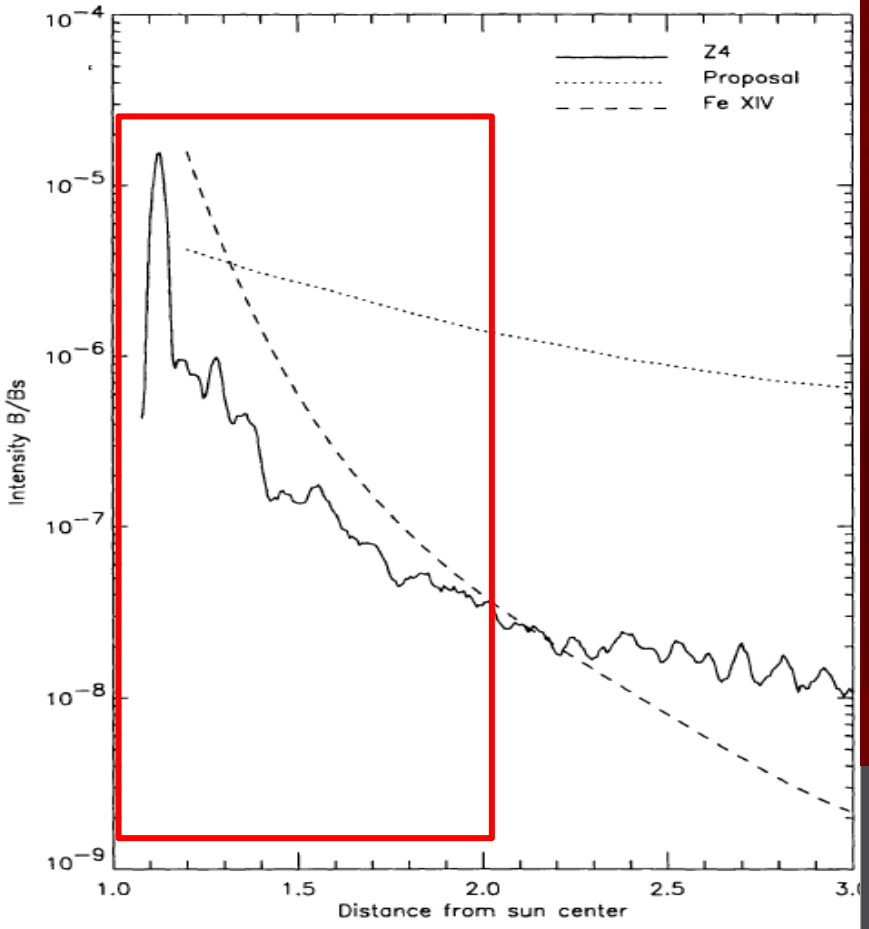
(Tu,C.Y.,et al., 2005)



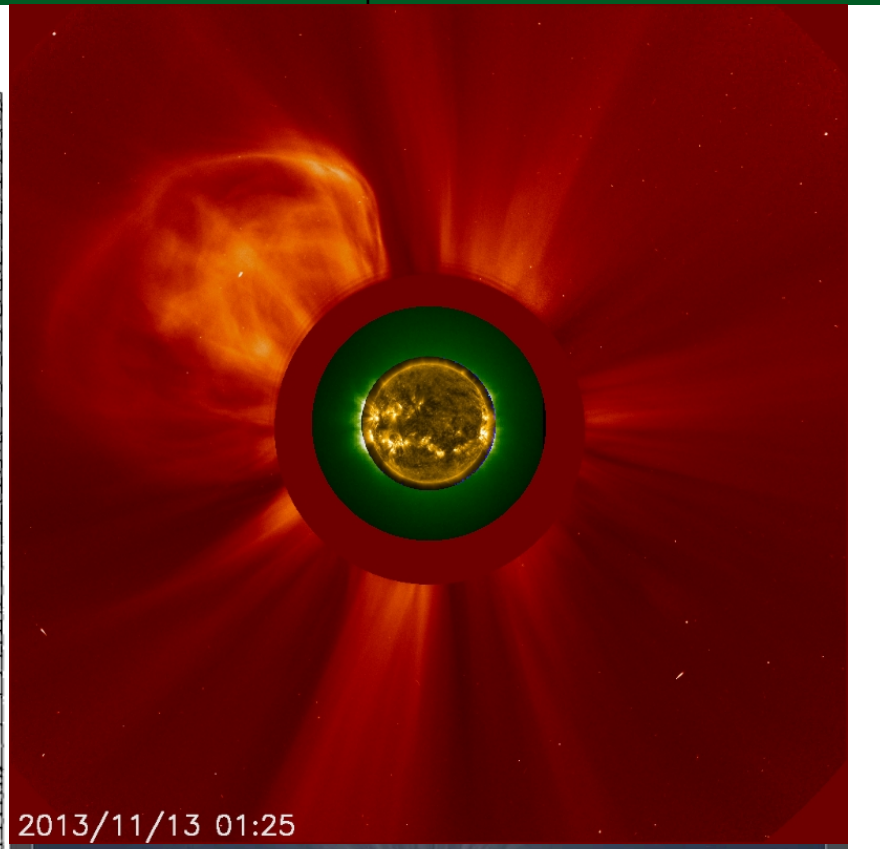
http://solarcyclescience.com/solarcycle.html

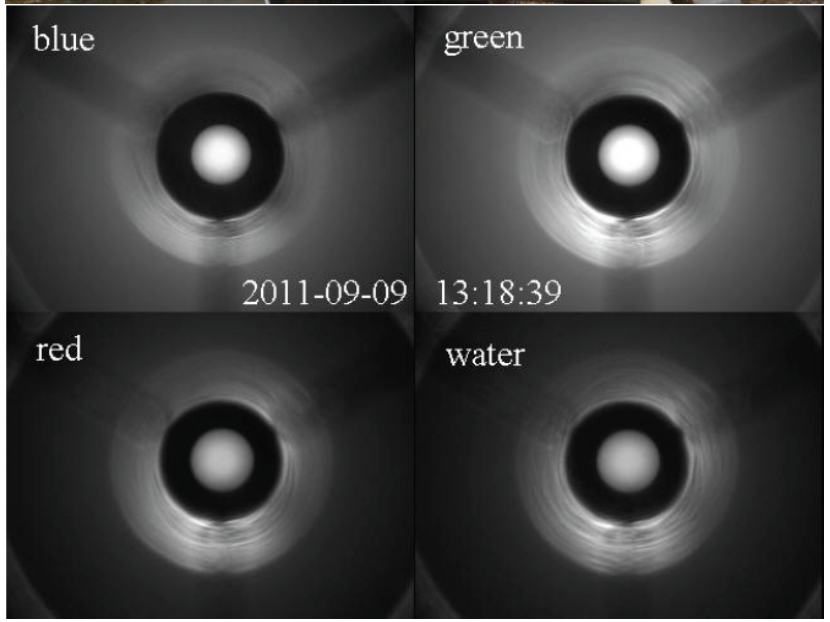


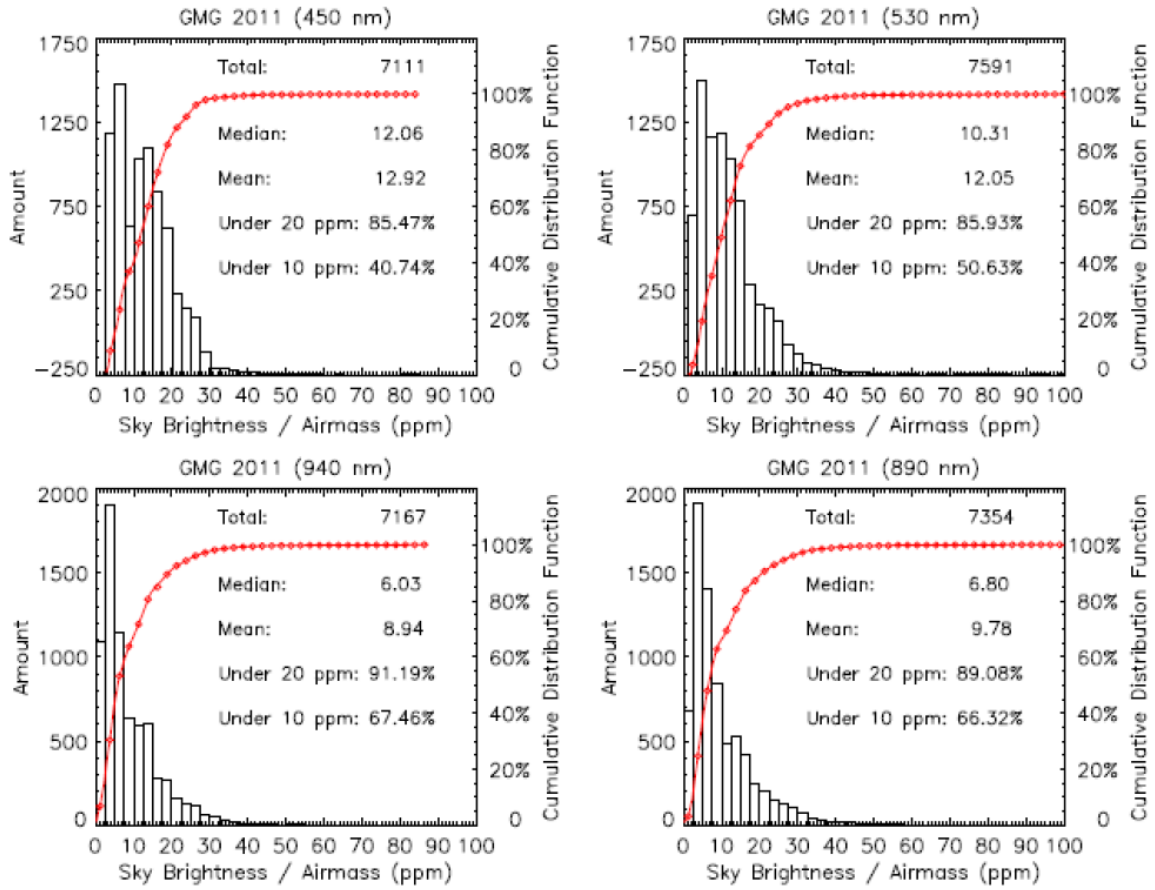
（Liberatore,A.,et al., 2022）



（Brueckner,G.E.,et al.,1995）

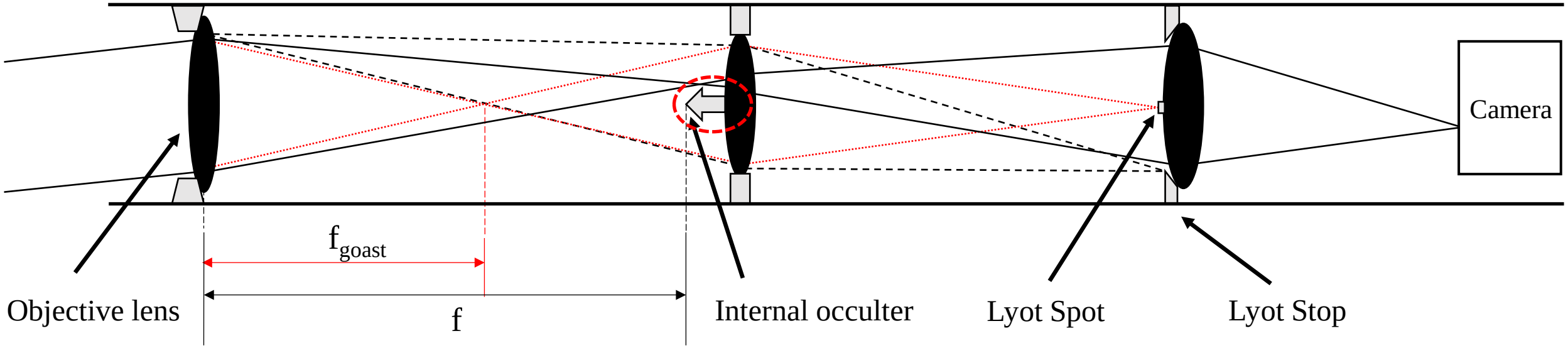






Zhang,X.F.,et al.,2019 **Zhao,M.Y.,et al.,2018**

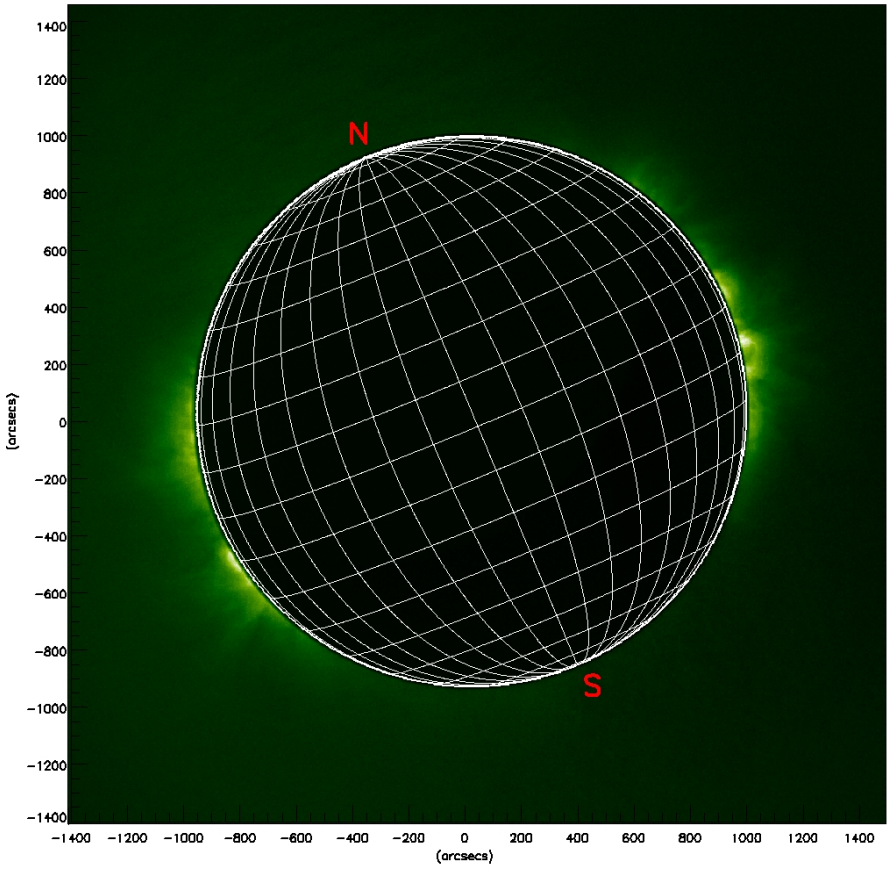
1. Direct sunlight.
2. Sunlight striking the telescope tube or lens edge.
3. Ghost image caused by multiple reflection.
4. Surface roughness or internal bubbles.
5. Dust on the objective

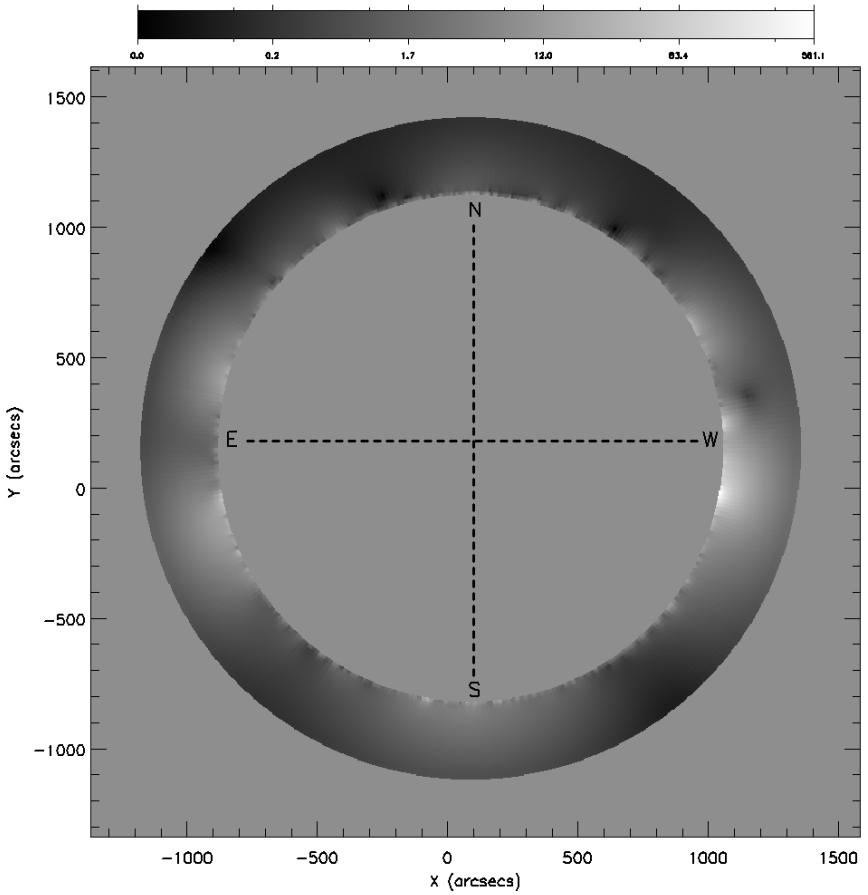


Lijiang 100 m coronagraph (YOGIS)

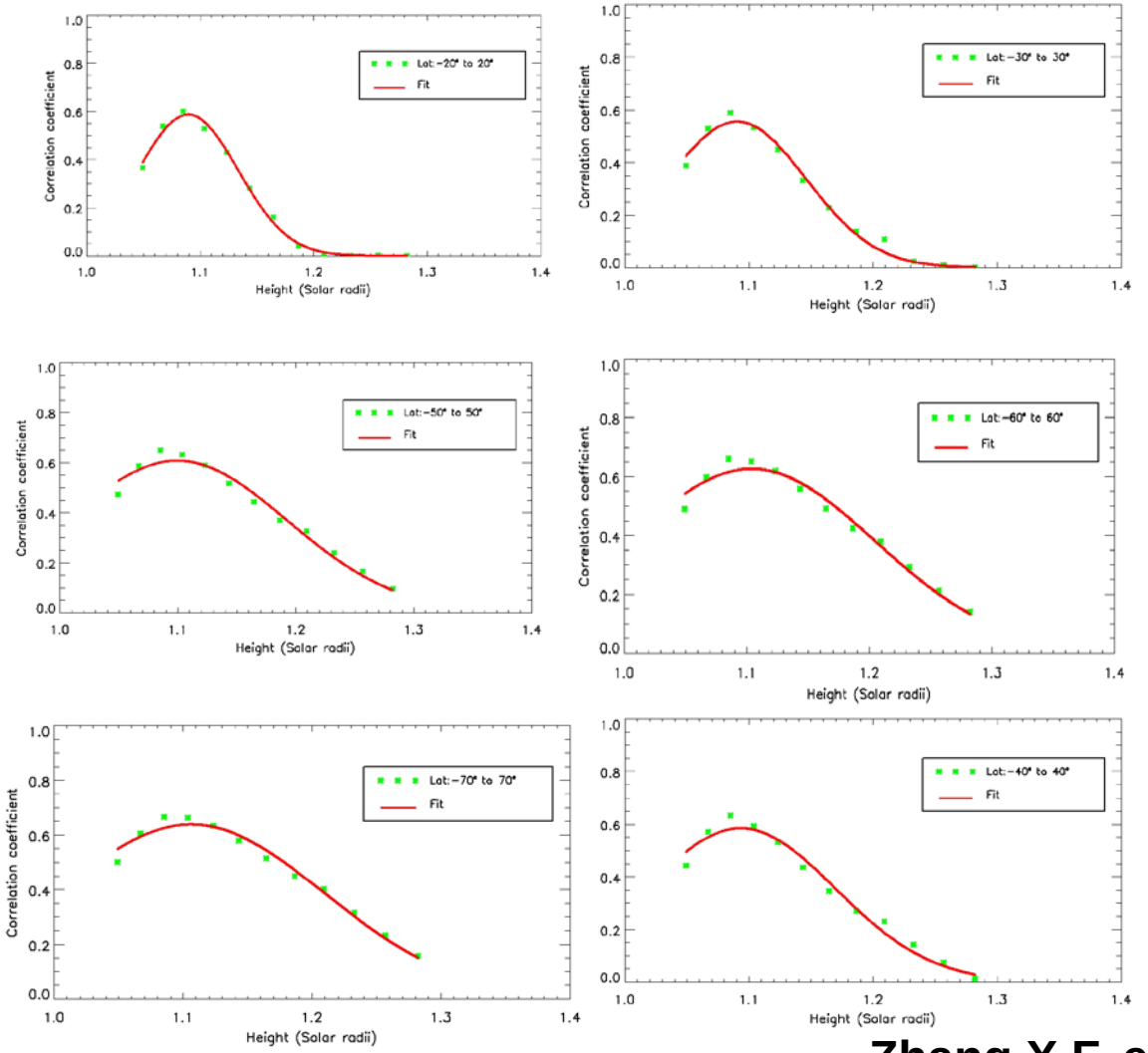
1997 ~ 2012, Norikura Solar Observatory, Japan (NOGIS)

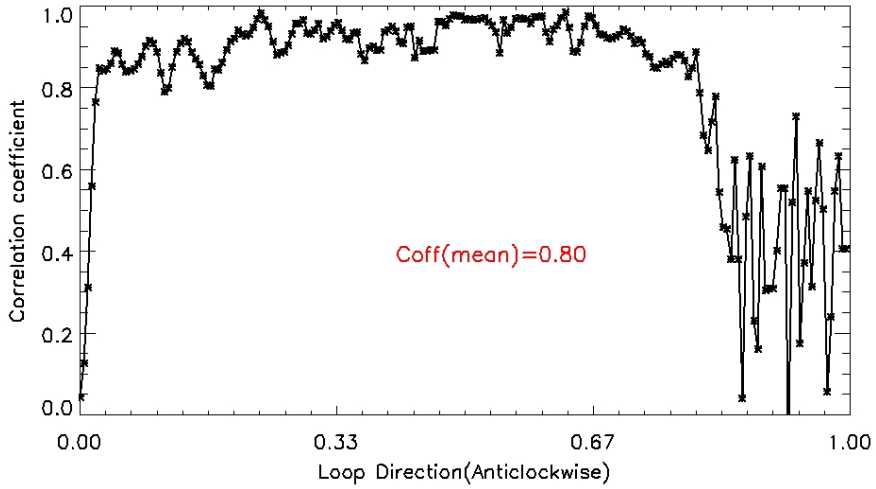
2013 ~ now, Lijiang Observatory, China (YOGIS)

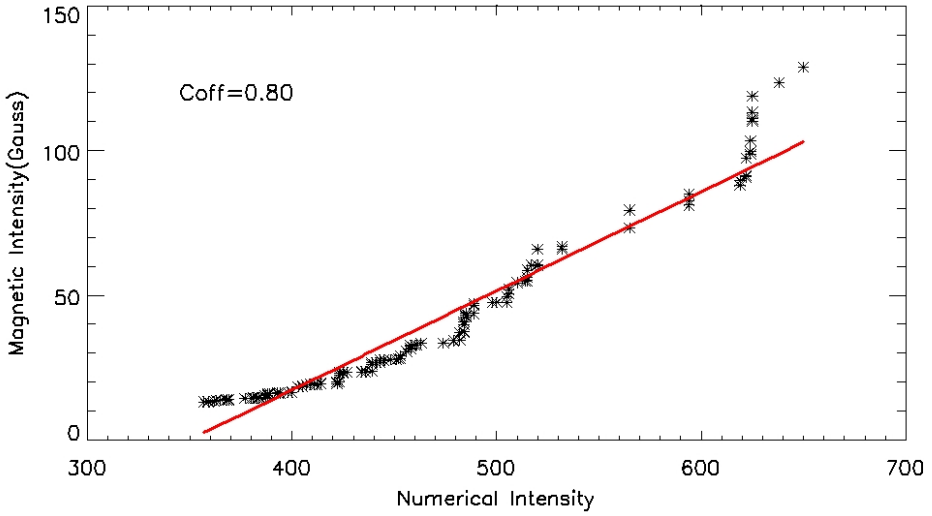




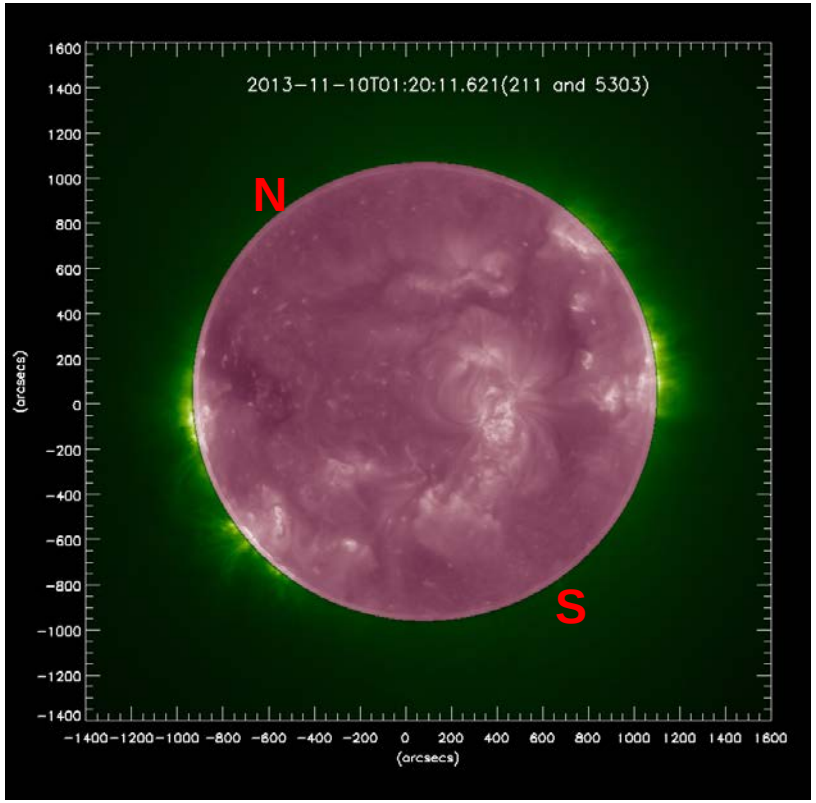
Zhang,X.F.,et al.,2022a

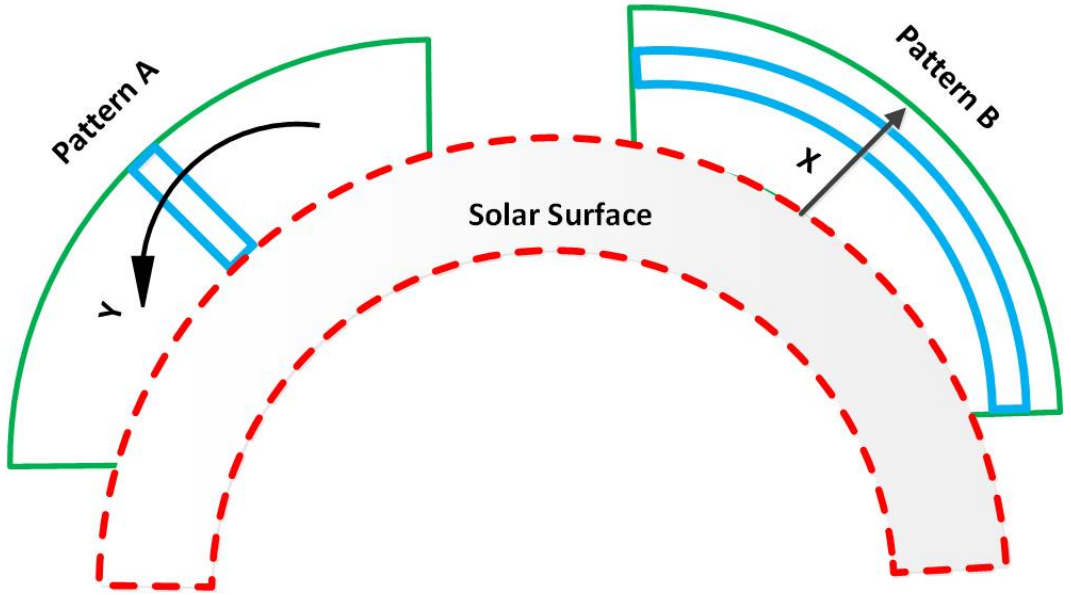




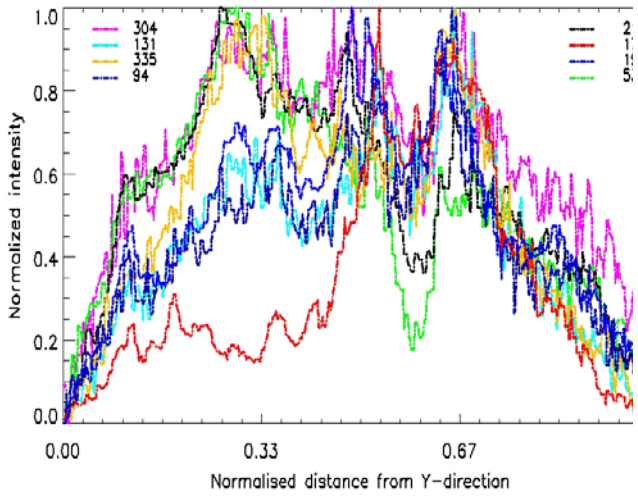


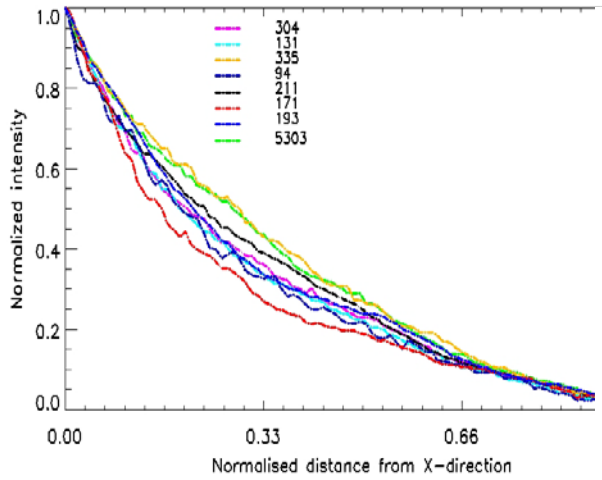
Zhang,X.F.,et al.,2022a

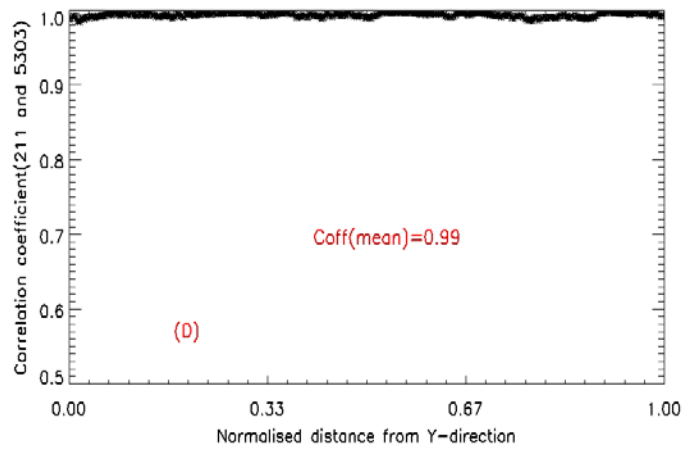


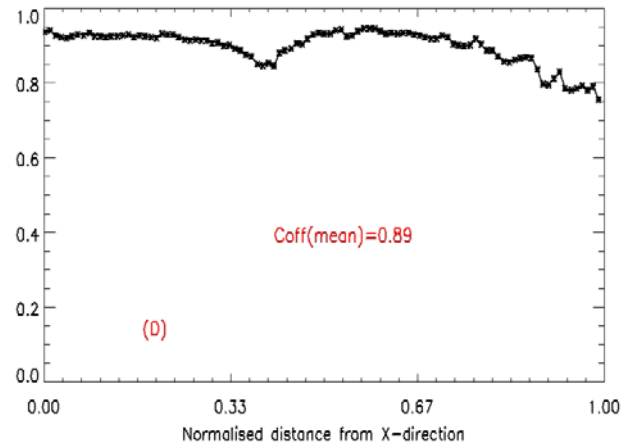


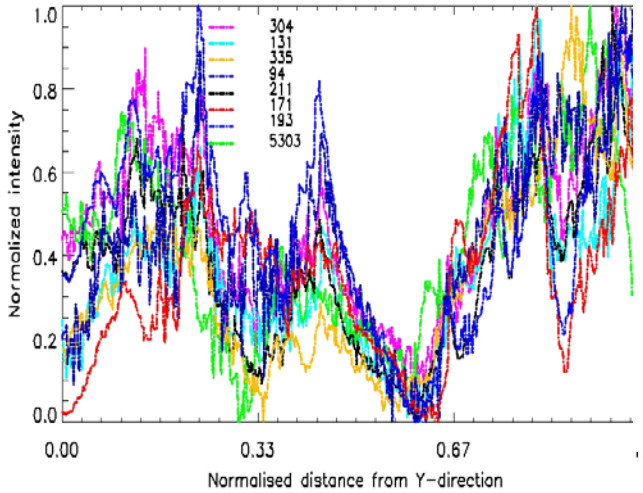
Zhang,X.F.,et al.,2022b

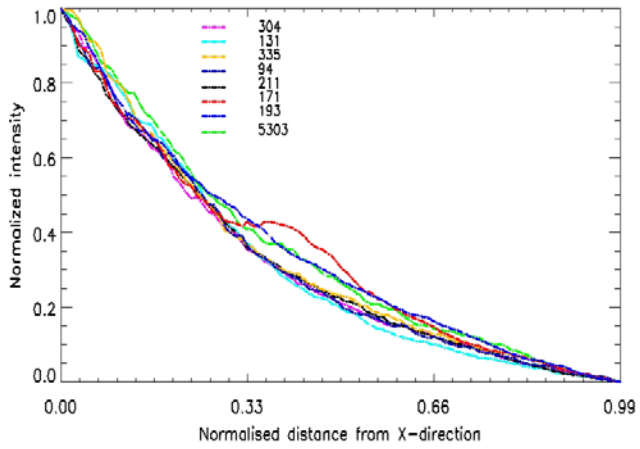


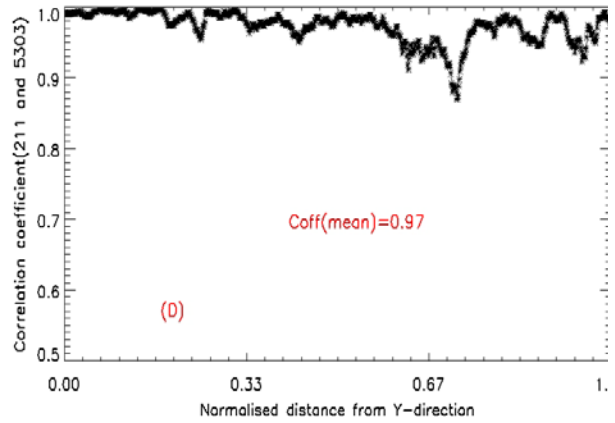


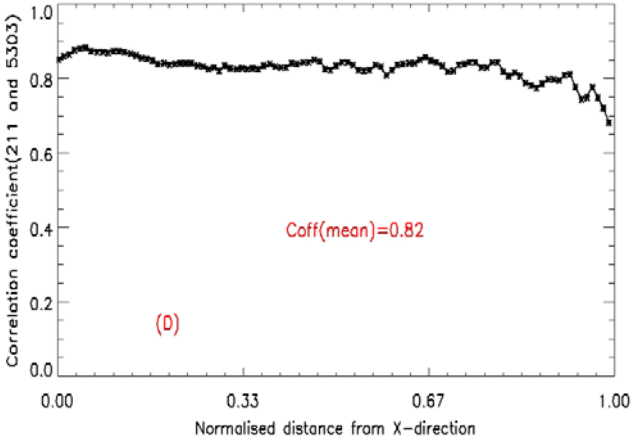












Zhang,X.F.,et al.,2022b

Variable stray light

Different dust amount on the objective

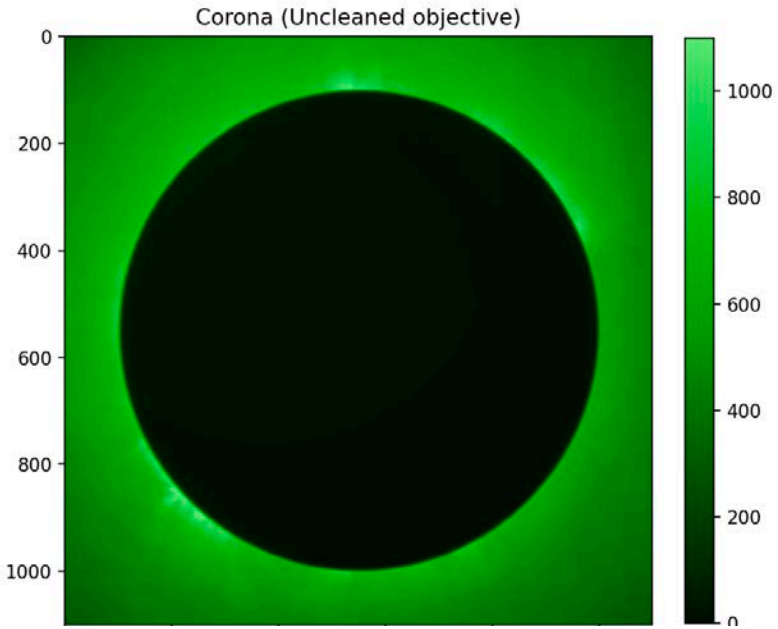
↓

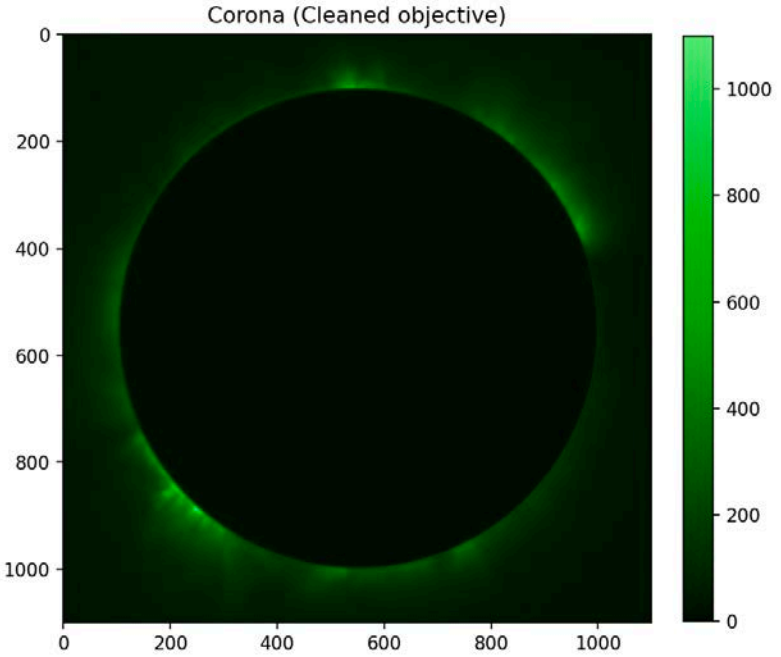
Varying scattering background on the coronal image

↓

Affect the analysis of the coronal structure

Affect the calibration of the coronal data





Remove the background

Clean the objective lens frequently

Can’t clean when observing

Frequent cleaning would damage the lens

Keep the dust amount in a relatively small range, but not zero

Data processing

Dust (amount or size) $\xrightarrow{?}$ Scattering background

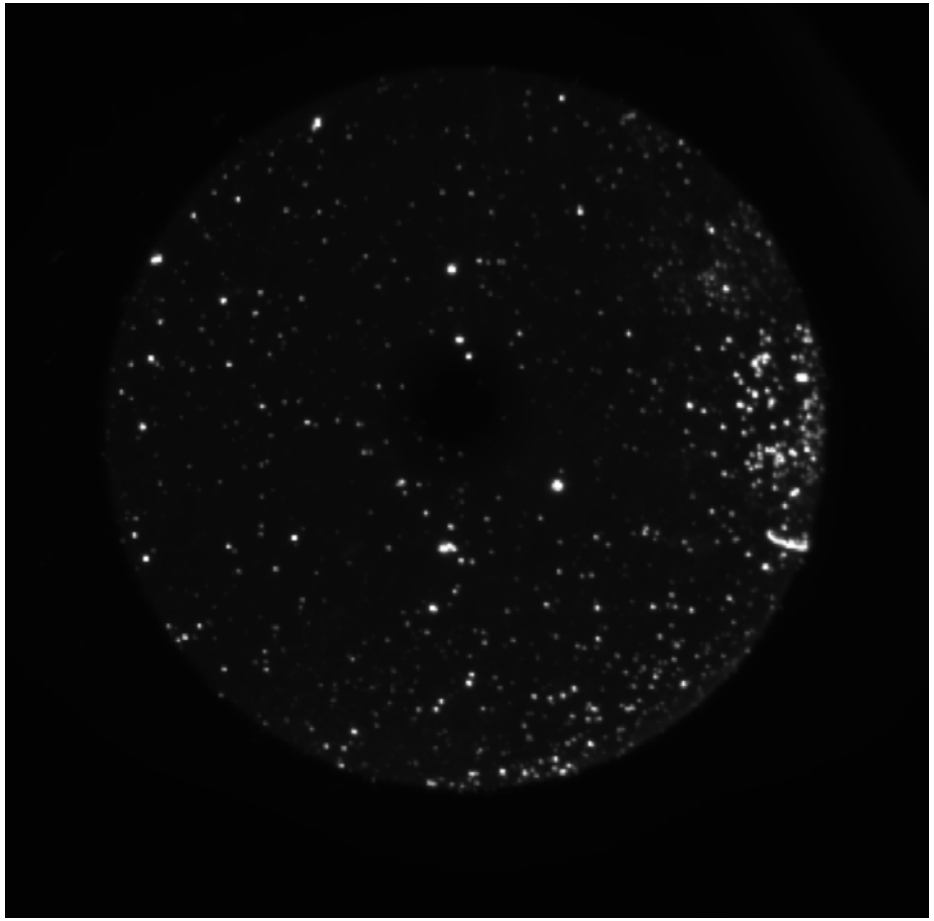
Experiments

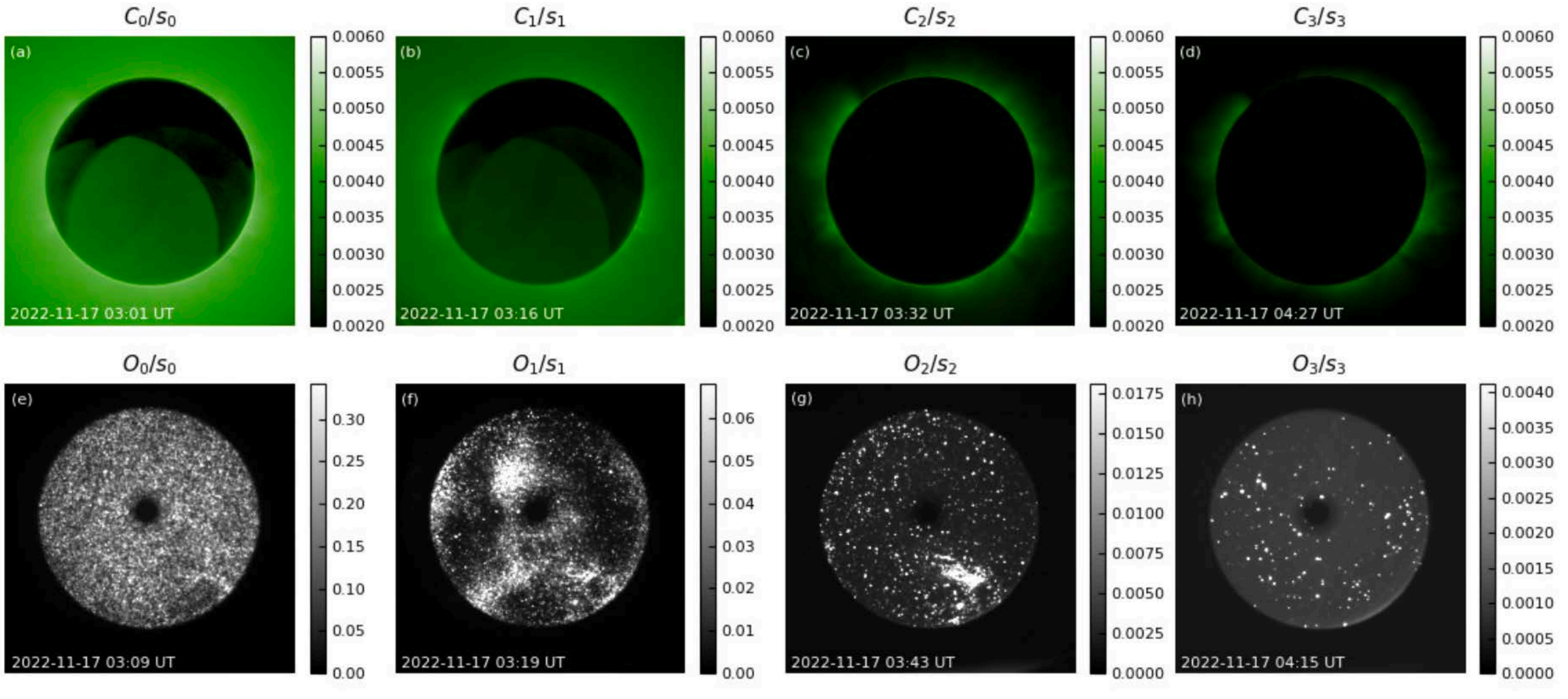
Dust

Scattered light formed by the micro-roughness of the objective.

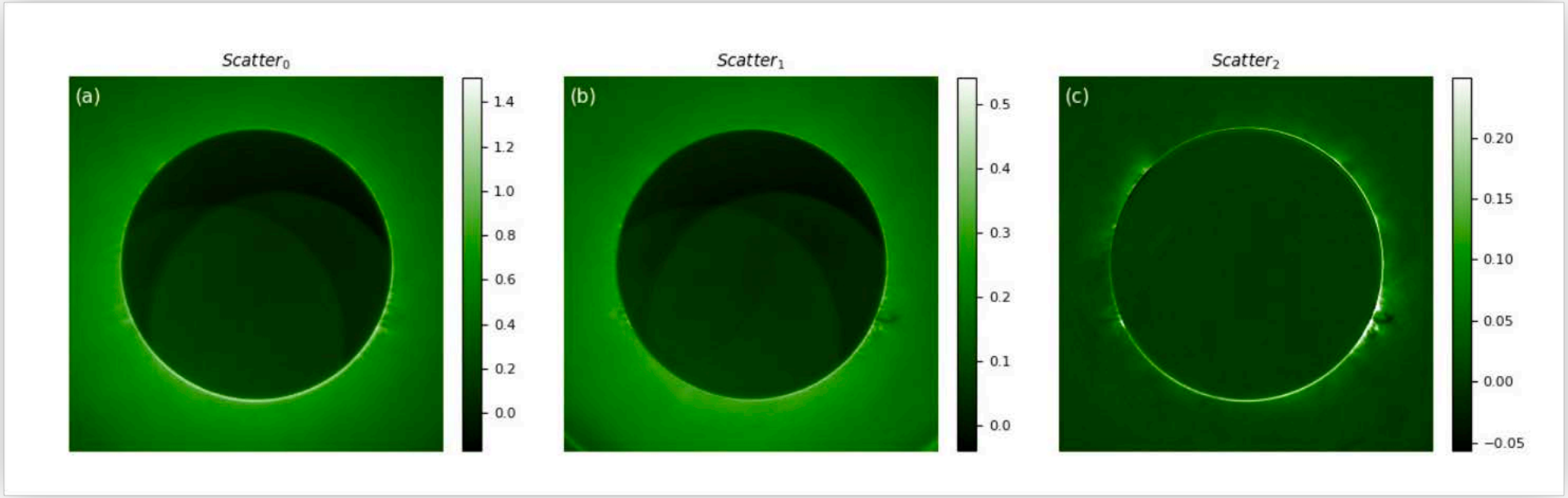
Scattering points formed by dust particles on the objective.

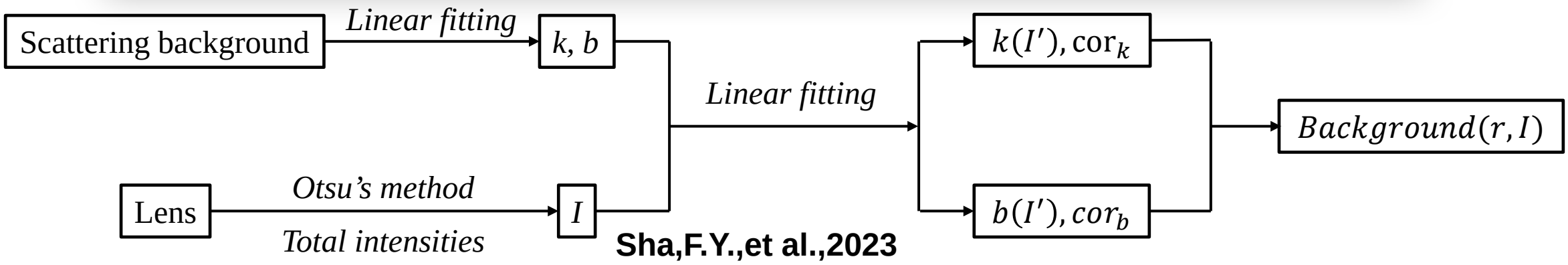
(describe the dust information)




C_0/s_0
(a)
2022-11-17 03:01 UT
0.0060 0.0055 0.0050 0.0045 0.0040 0.0035 0.0030 0.0025 0.0020
C_1/s_1
(b)
2022-11-17 03:16 UT
0.0060 0.0055 0.0050 0.0045 0.0040 0.0035 0.0030 0.0025 0.0020
C_2/s_2
(c)
2022-11-17 03:32 UT
0.0060 0.0055 0.0050 0.0045 0.0040 0.0035 0.0030 0.0025 0.0020
C_3/s_3
(d)
2022-11-17 04:27 UT
0.0060 0.0055 0.0050 0.0045 0.0040 0.0035 0.0030 0.0025 0.0020
O_0/s_0
(e)
2022-11-17 03:09 UT
0.30 0.25 0.20 0.15 0.10 0.05 0.00
O_1/s_1
(f)
2022-11-17 03:19 UT
0.06 0.05 0.04 0.03 0.02 0.01 0.00
O_2/s_2
(g)
2022-11-17 03:43 UT
0.0175 0.0150 0.0125 0.0100 0.0075 0.0050 0.0025 0.0000
O_3/s_3
(h)
2022-11-17 04:15 UT
0.0040 0.0035 0.0030 0.0025 0.0020 0.0015 0.0010 0.0005 0.0000

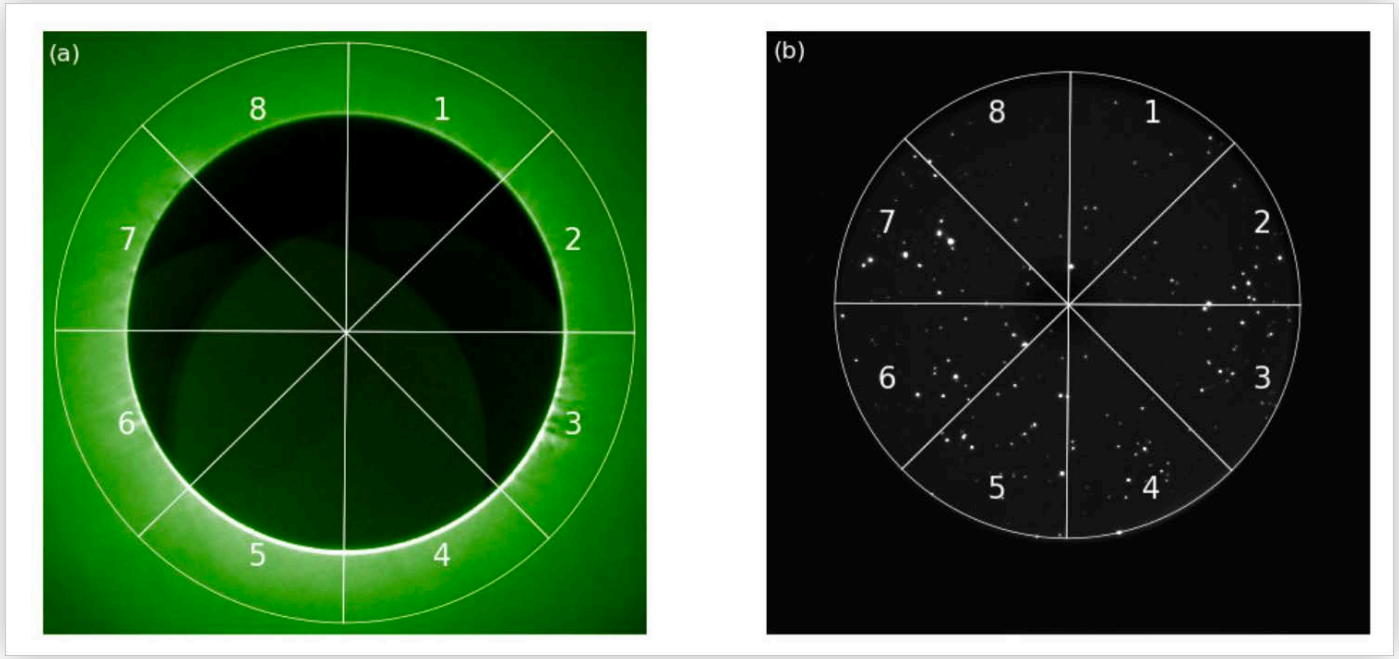
Model 1





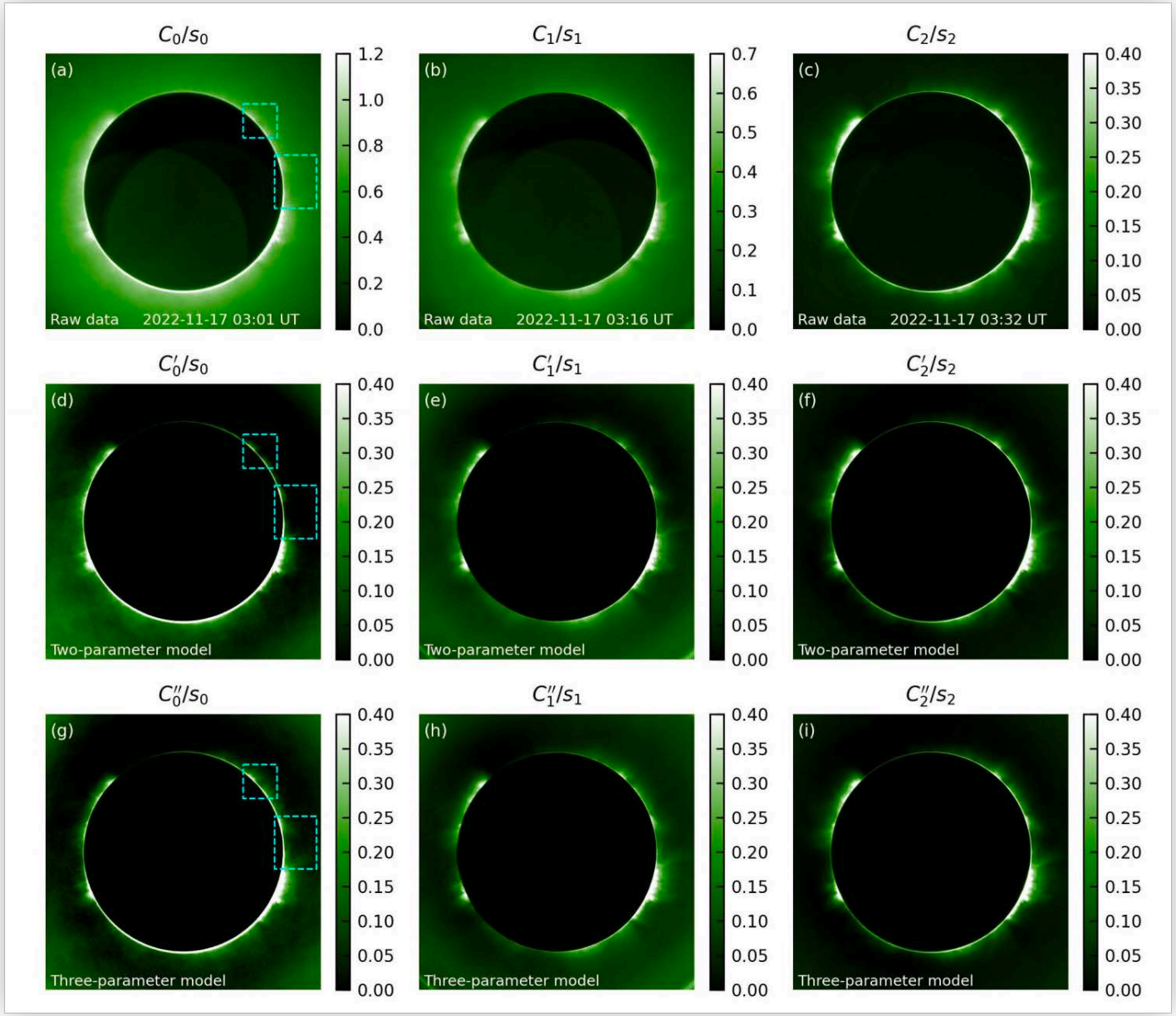
Sha,F.Y.,et al.,2023

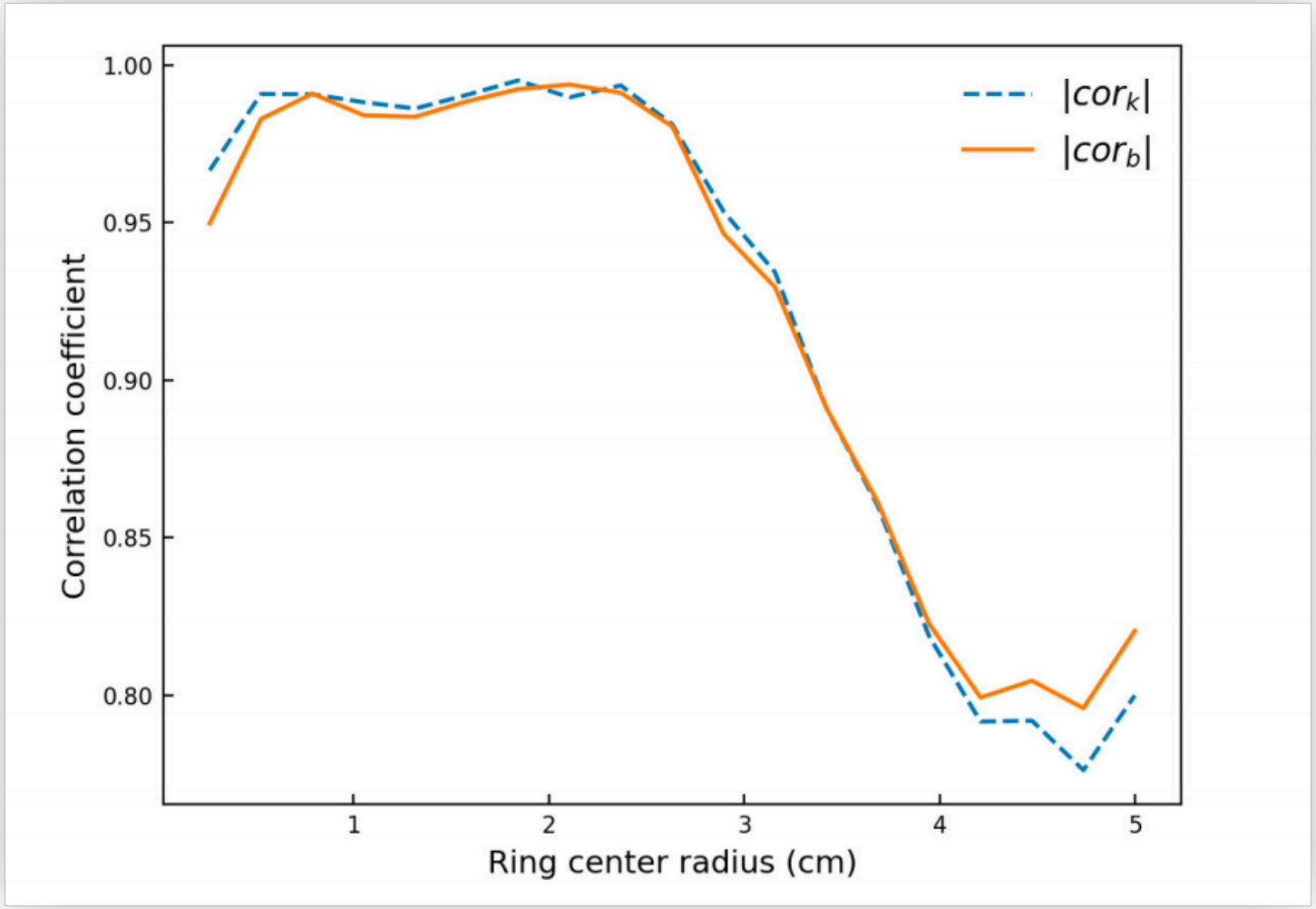
Model 2



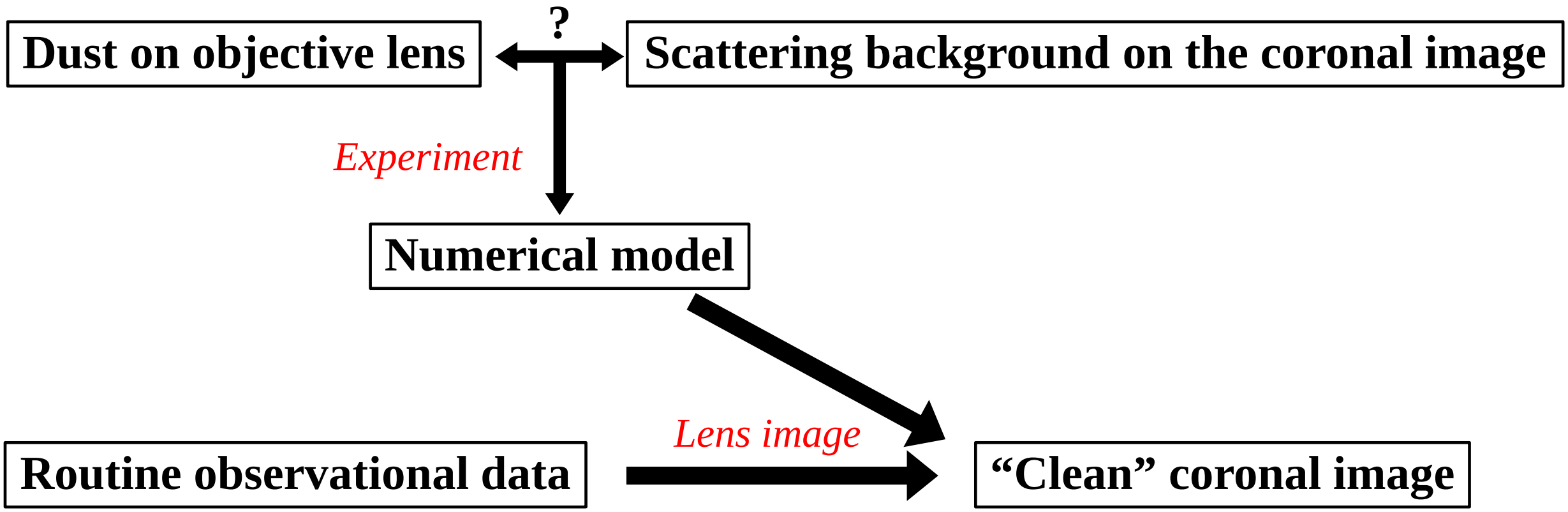
$$\text{Distance} = \begin{cases} n-m & m \leq n \\ n-m+N & m > n \end{cases}.$$

Sha,F.Y.,et al.,2023


C_0/s_0
(a)
Raw data 2022-11-17 03:01 UT
C_1/s_1
(b)
Raw data 2022-11-17 03:16 UT
C_2/s_2
(c)
Raw data 2022-11-17 03:32 UT
C_0'/s_0
(d)
Two-parameter model
C_1'/s_1
(e)
Two-parameter model
C_2'/s_2
(f)
Two-parameter model
C_0''/s_0
(g)
Three-parameter model
C_1''/s_1
(h)
Three-parameter model
C_2''/s_2
(i)
Three-parameter model


1.00
0.95
0.90
0.85
0.80
Correlation coefficient
1
2
3
4
5
Ring center radius (cm)
$|cor_k|$
$|cor_b|$

Conclusion


Dust on objective lens
?
Scattering background on the coronal image
Experiment
Numerical model
Lens image
Routine observational data
“Clean” coronal image

Conclusion

Enable a more accurate analysis of coronal structure.

Crucial for the high-precision calibration of ground-based coronagraph data.

Support the provision of reliable observational data for future routine measurements of the coronal magnetic field using coronagraphs.

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THANKS!

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