Biserni oblaki in uklon

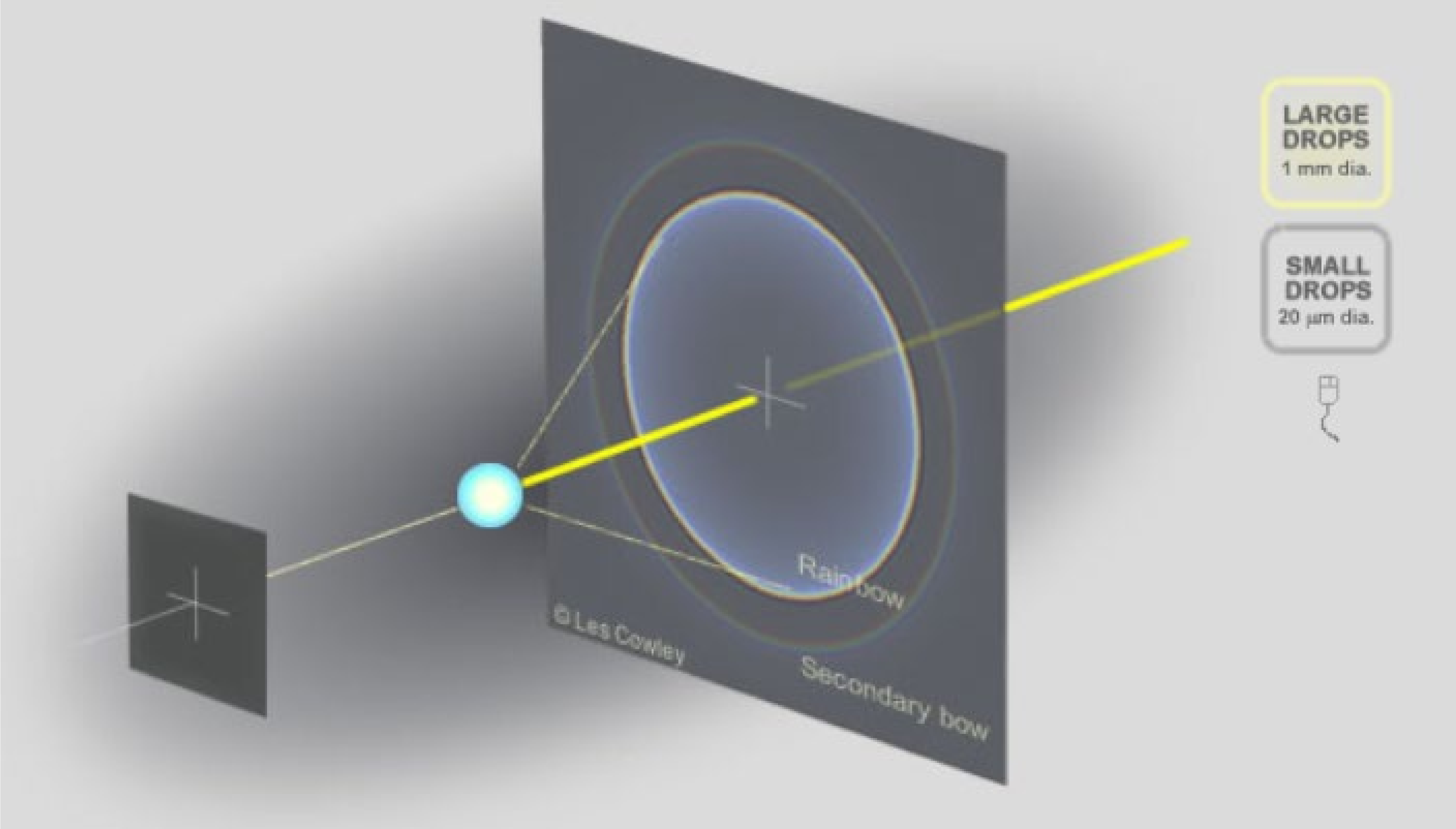
naravoslovna fotografija, Presek 51, 4

naravoslovna fotografija = naslovnica

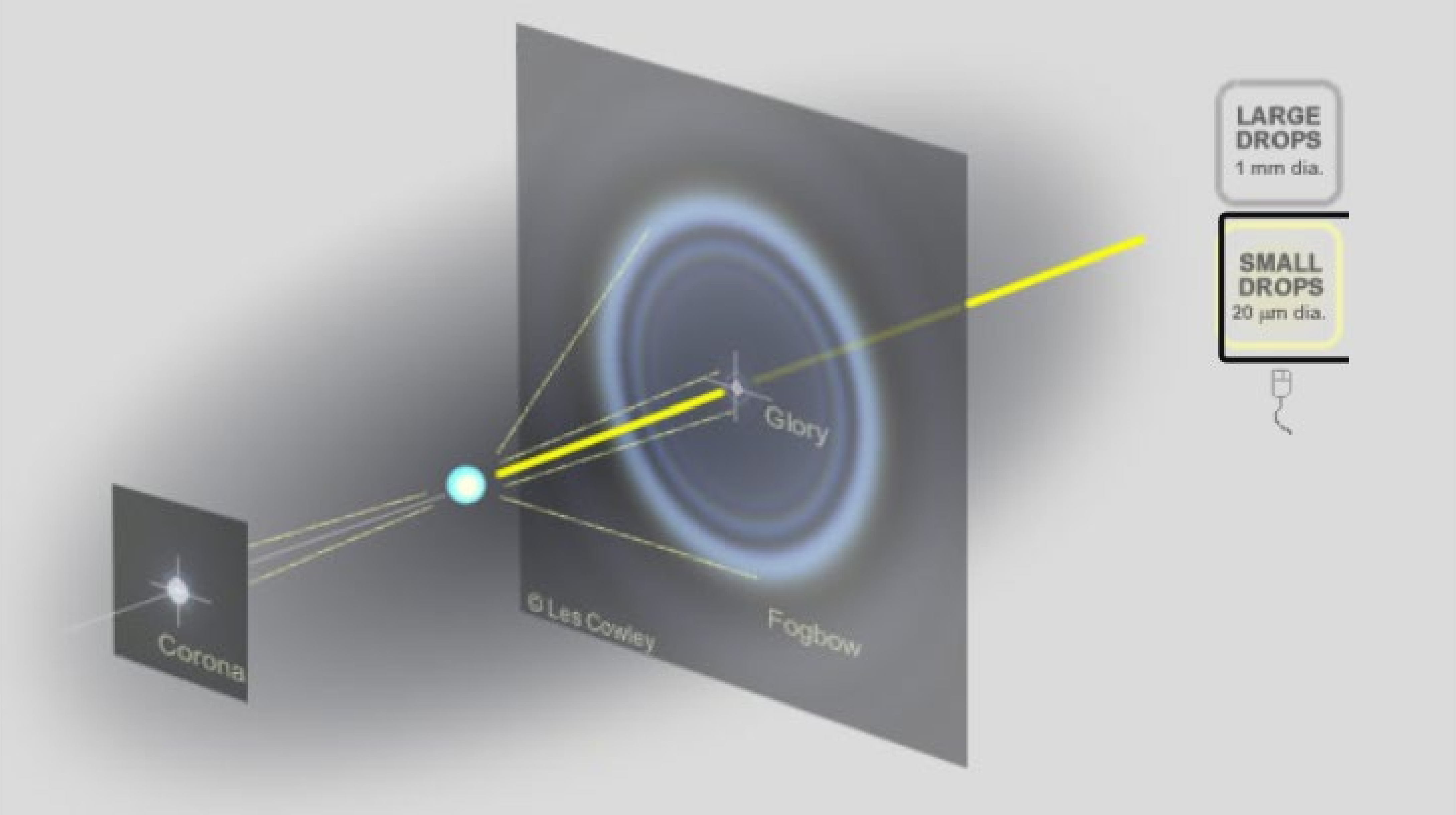
fotometeorji

- halo
- mavrica
- megleni lok
- iridescenca oblakov (ali irizacija)
- glorija
- Bishopov prstan
- korona
- krepuskularni žarki
- sončni psi
- svetlobni steber
- privid/fatamorgana
- scintilacija/migotanje
- zeleni blisk

Brent Mckean

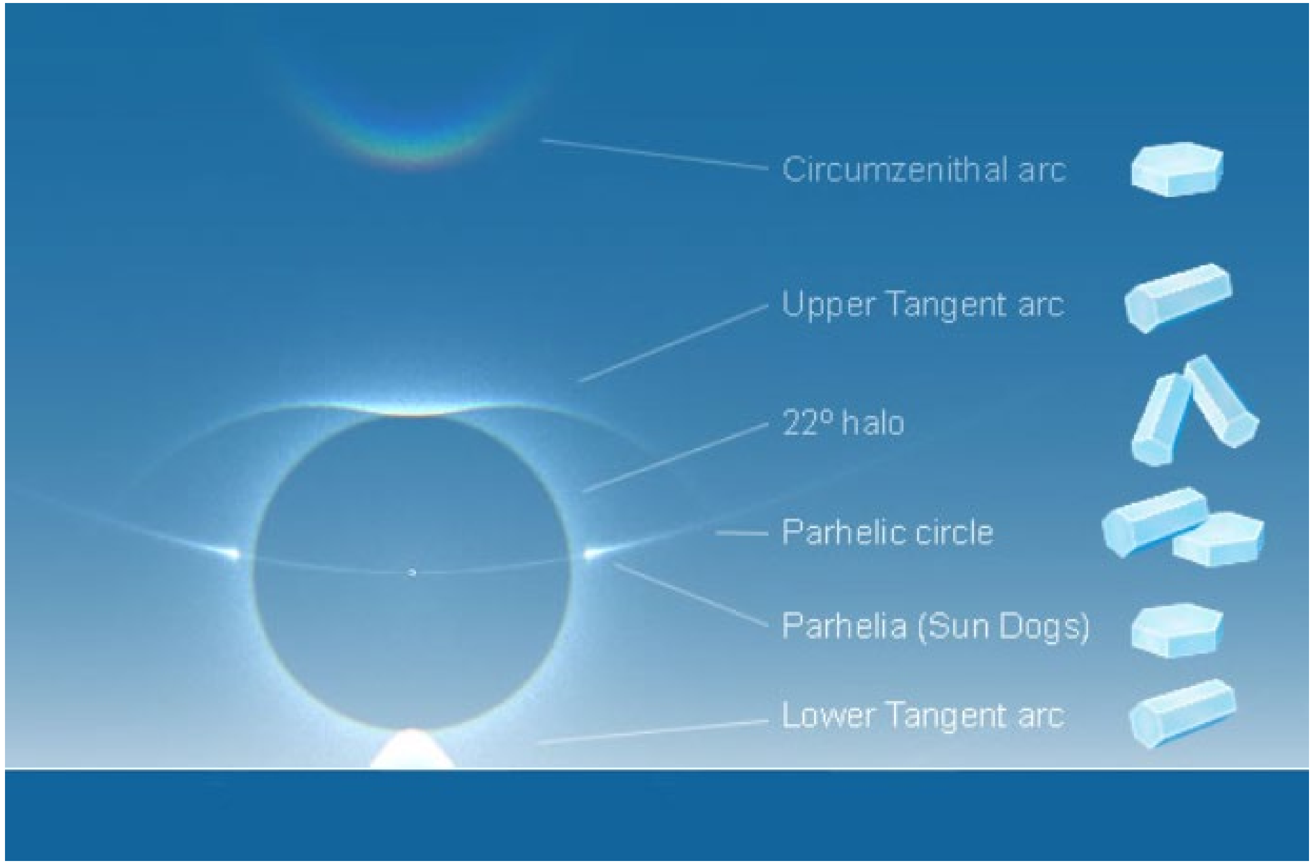


https://atoptics.co.uk/


LARGE DROPS
1 mm dia.
SMALL DROPS
20 µm dia.
Glory
Corona
© Les Cowley
Fogbow

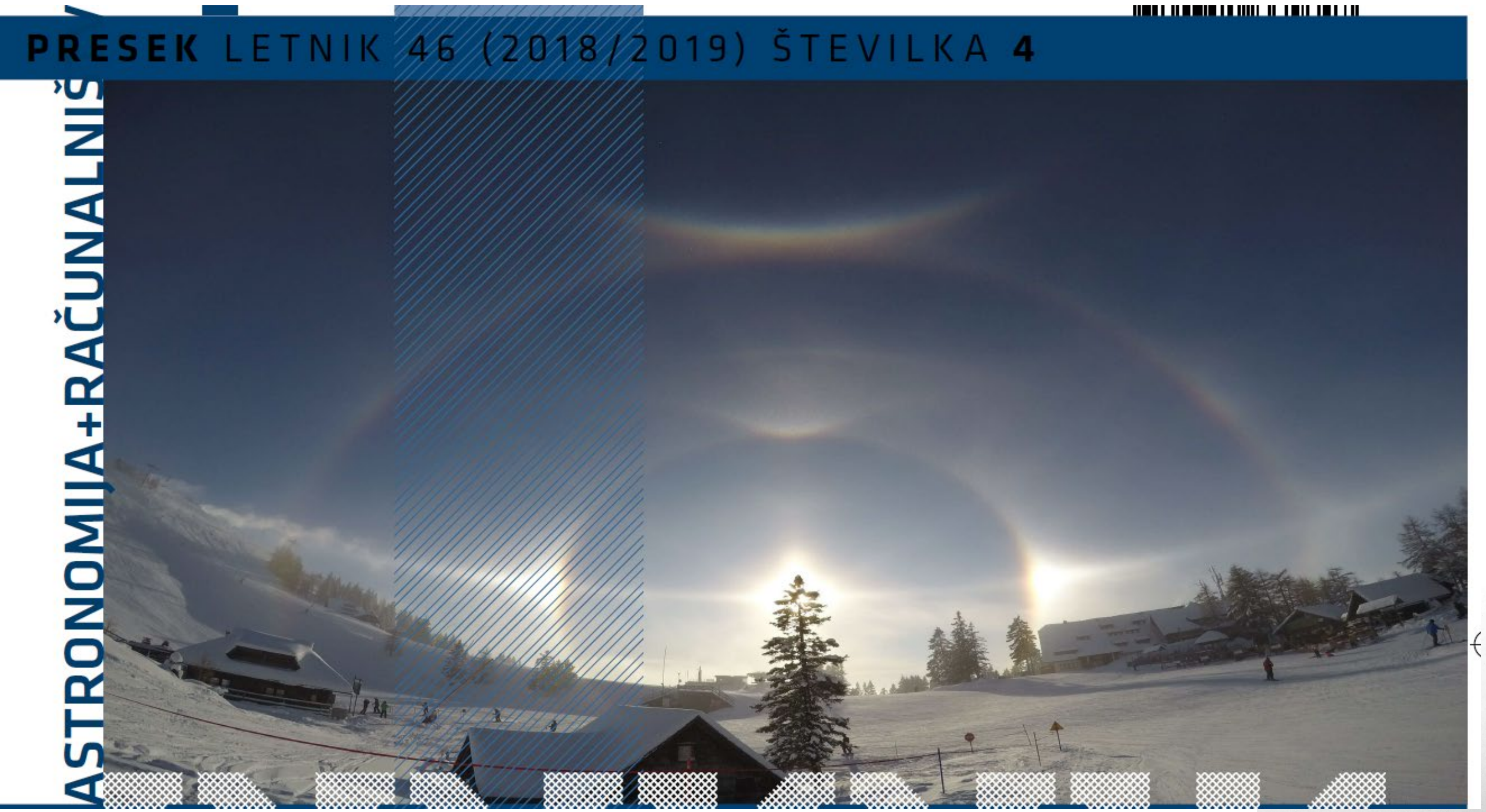
halo

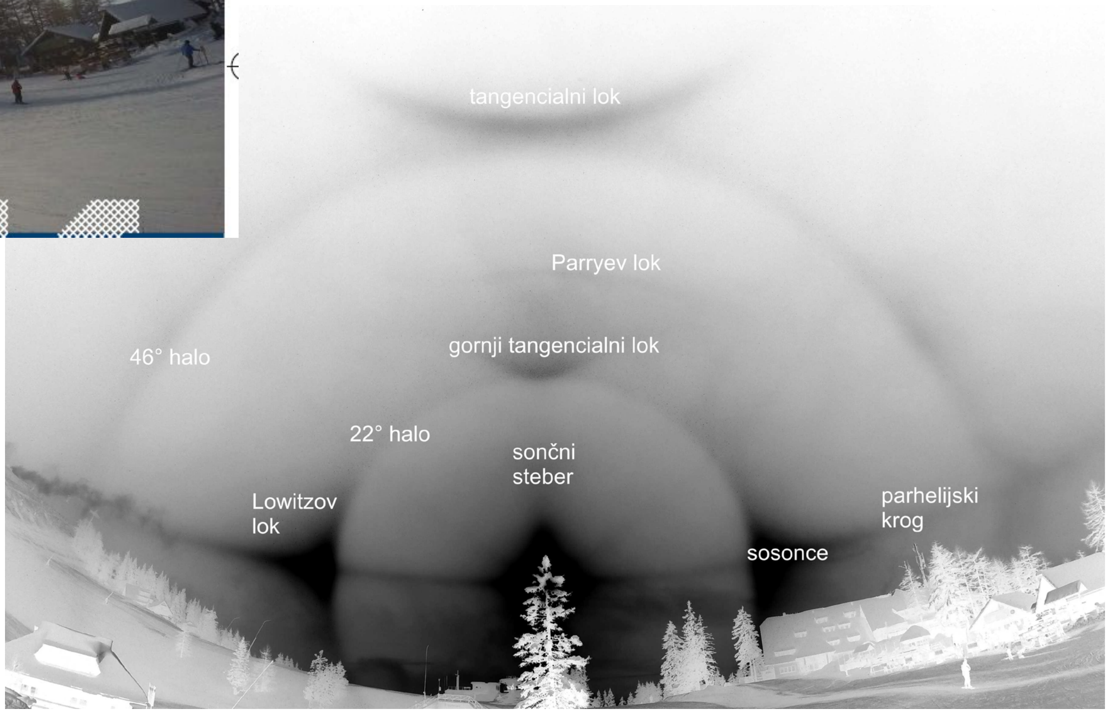
PRESEK **44** (2016/2017) 3



https://en.wikipedia.org/wiki/22%C2%B0_halo

PRESEK **44** (2016/2017) 4


PRESEK LETNIK 46 (2018/2019) ŠTEVILKA 4
ASTRONOMIJA+RAČUNALNIŠ

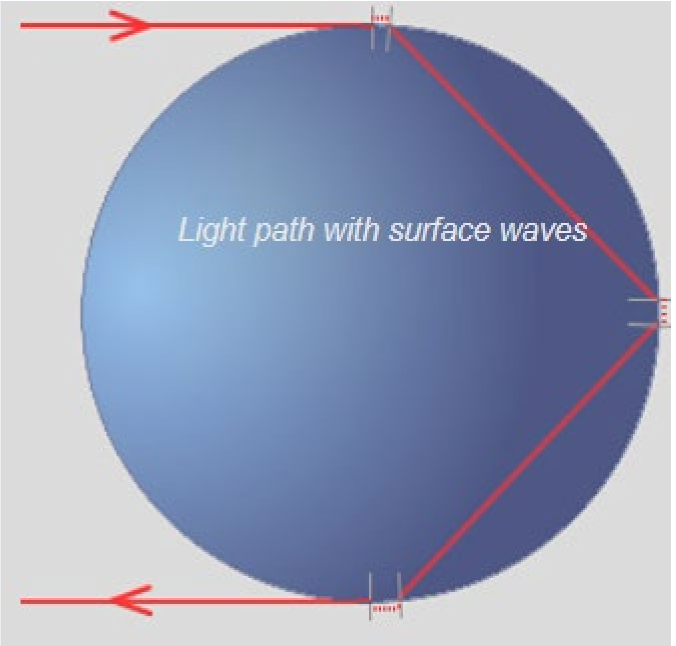

tangencialni lok
Parryev lok
gornji tangencialni lok
46° halo
22° halo
sončni
steber
Lowitzov
lok
parhelijski
krog
sosonce

sosonce

sončni steber

Presek 38 (2010/2011) 5

glorija



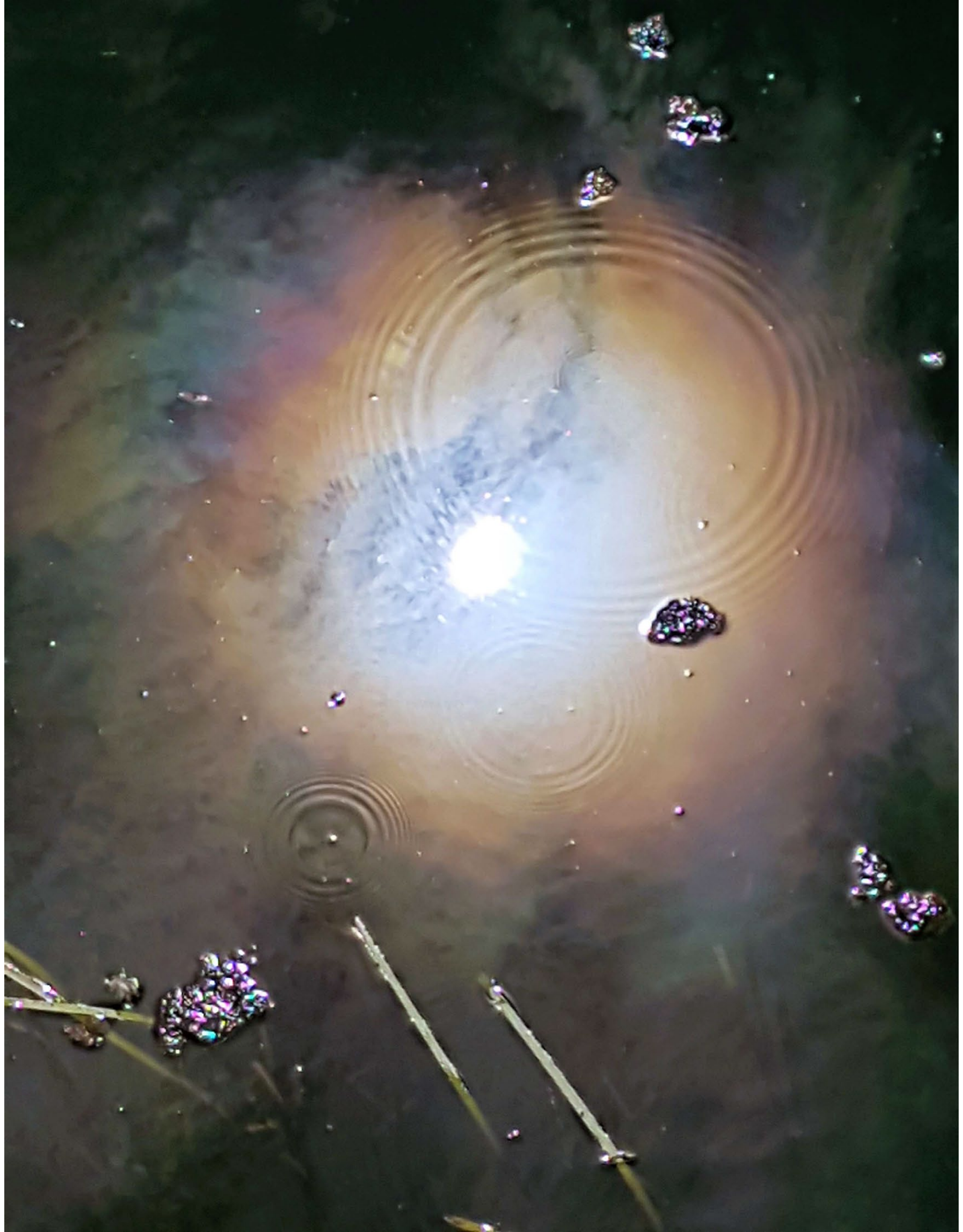
https://en.wikipedia.org/wiki/Glory_(optical_phenomenon)

korona

https://en.wikipedia.org/wiki/Corona_(optical_phenomenon)

korona

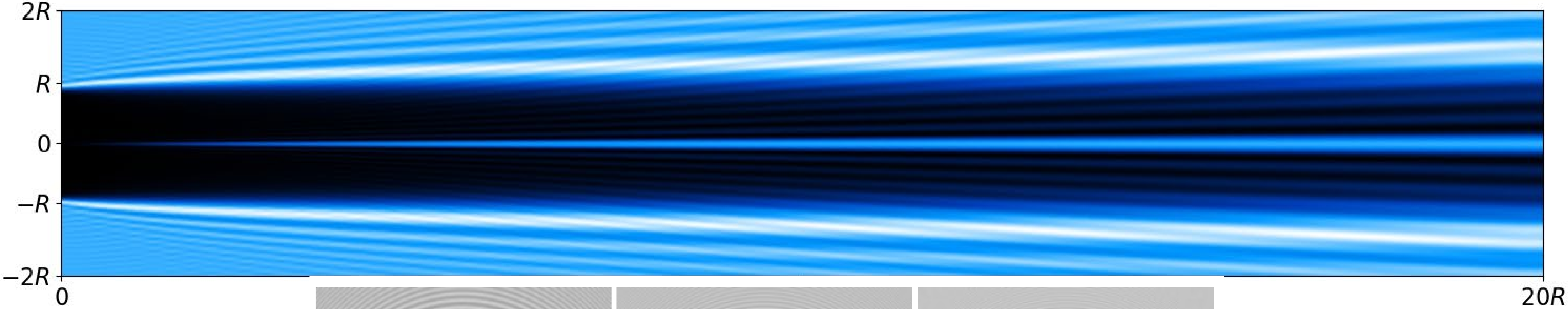
PRESEK **45** (2017/2018) 1

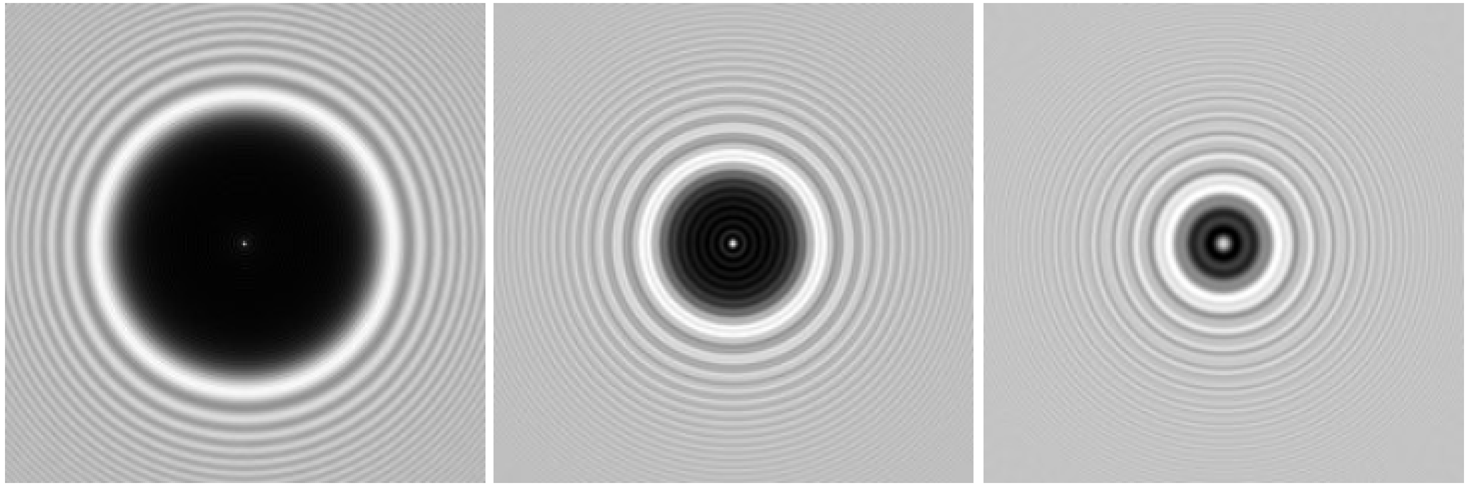


korona - venec

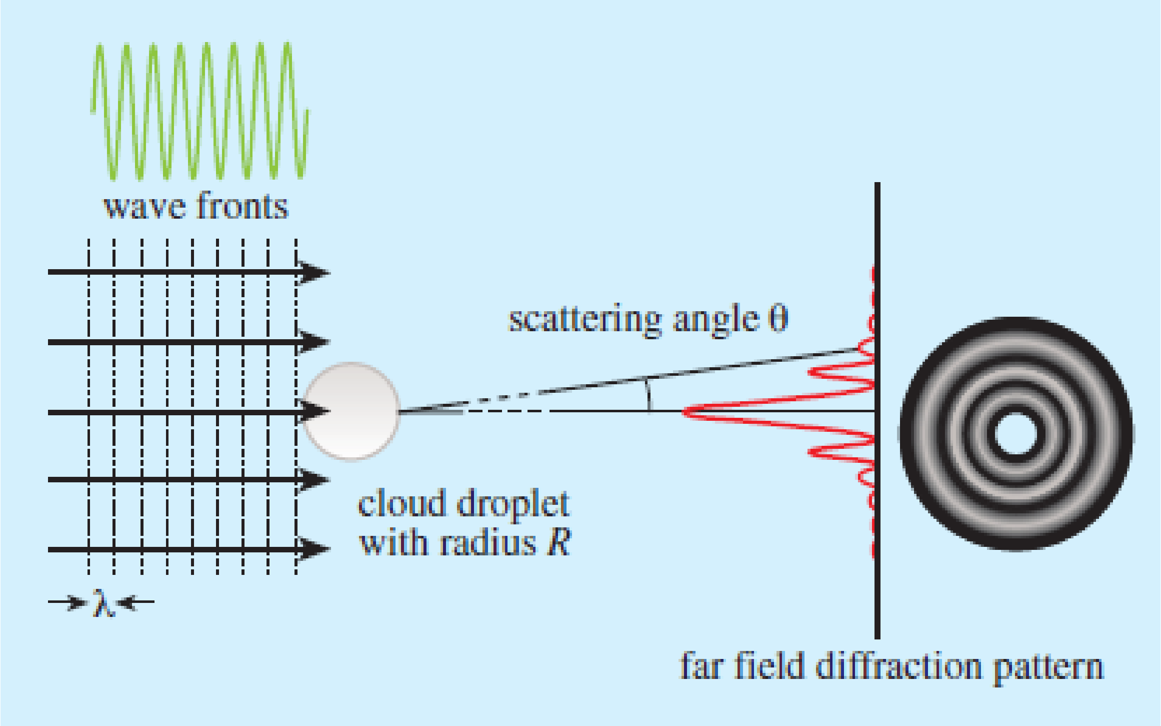
presek 40 (2012/2013) 5

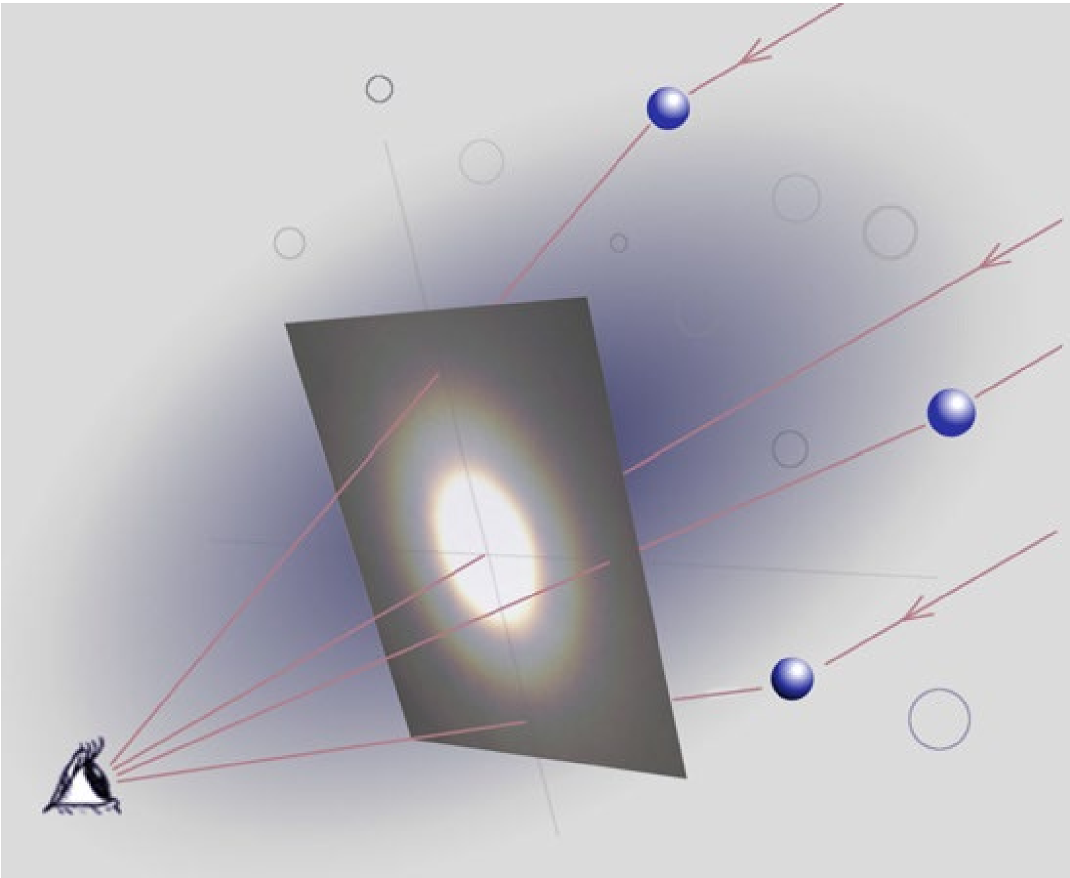
uklon na okrogli oviri

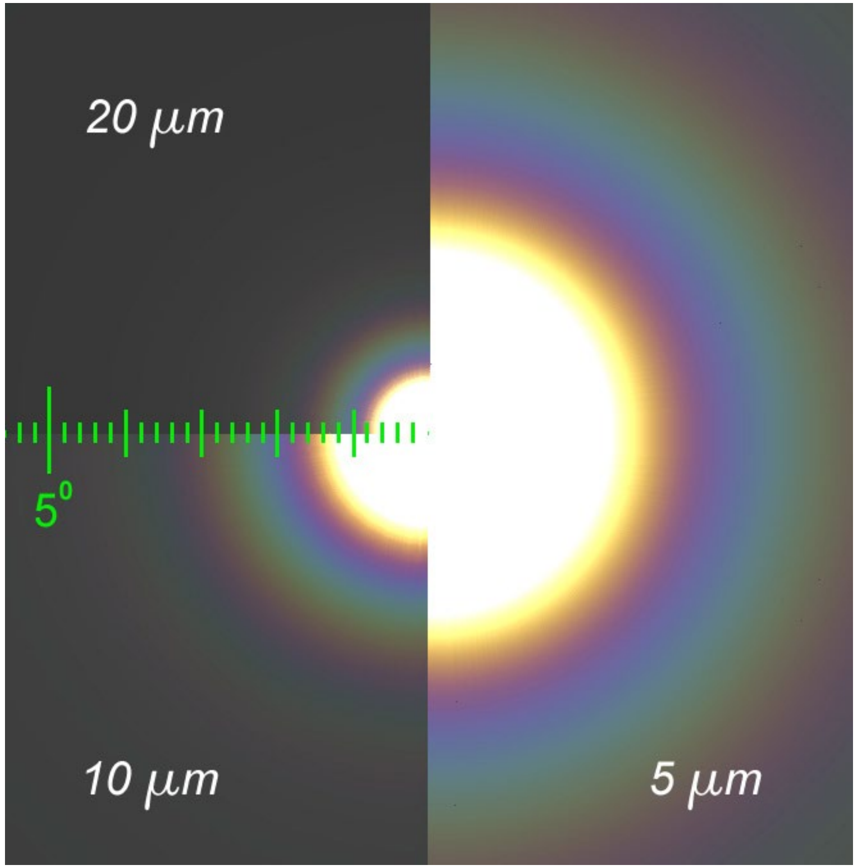


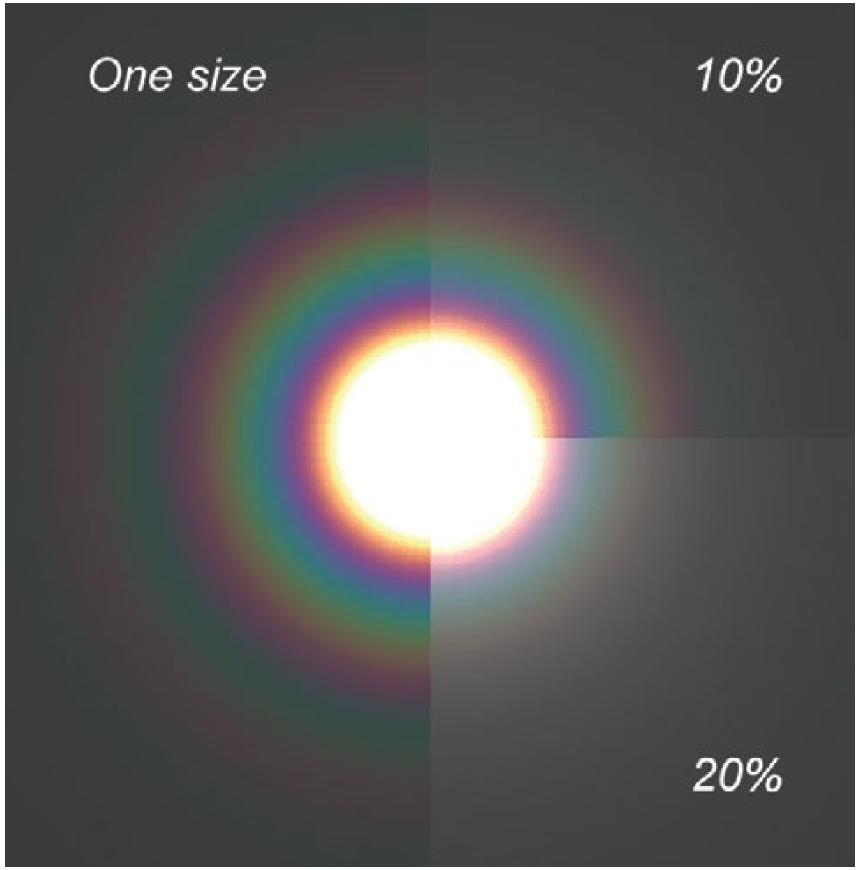


https://en.wikipedia.org/wiki/Arago_spot


wave fronts
scattering angle θ
cloud droplet
with radius R
λ
far field diffraction pattern

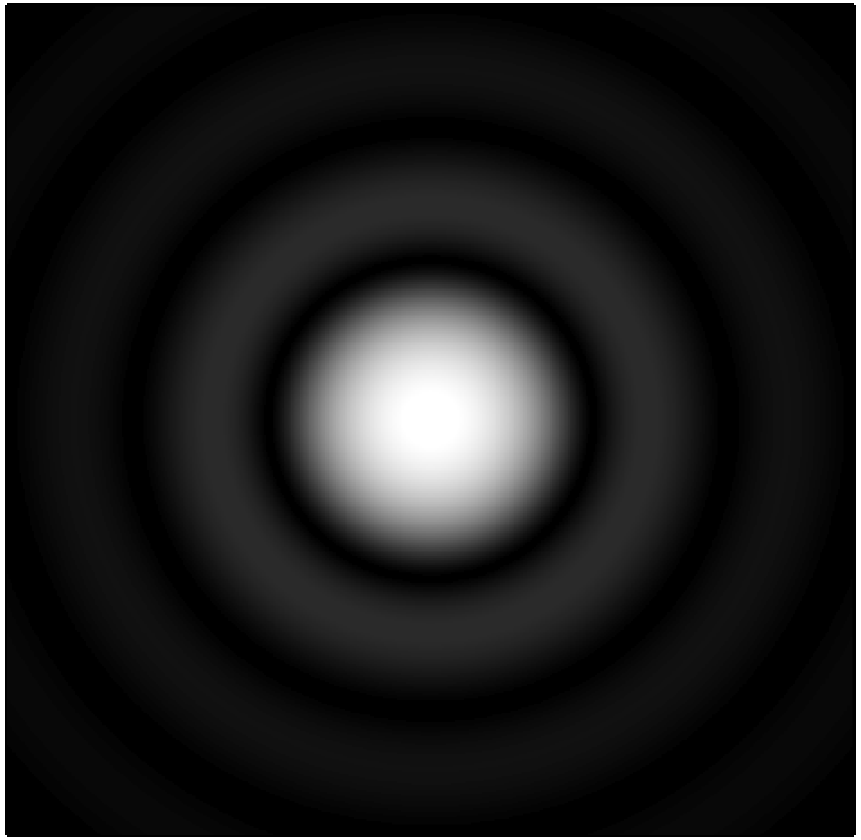



20 μm
5°
10 μm
5 μm

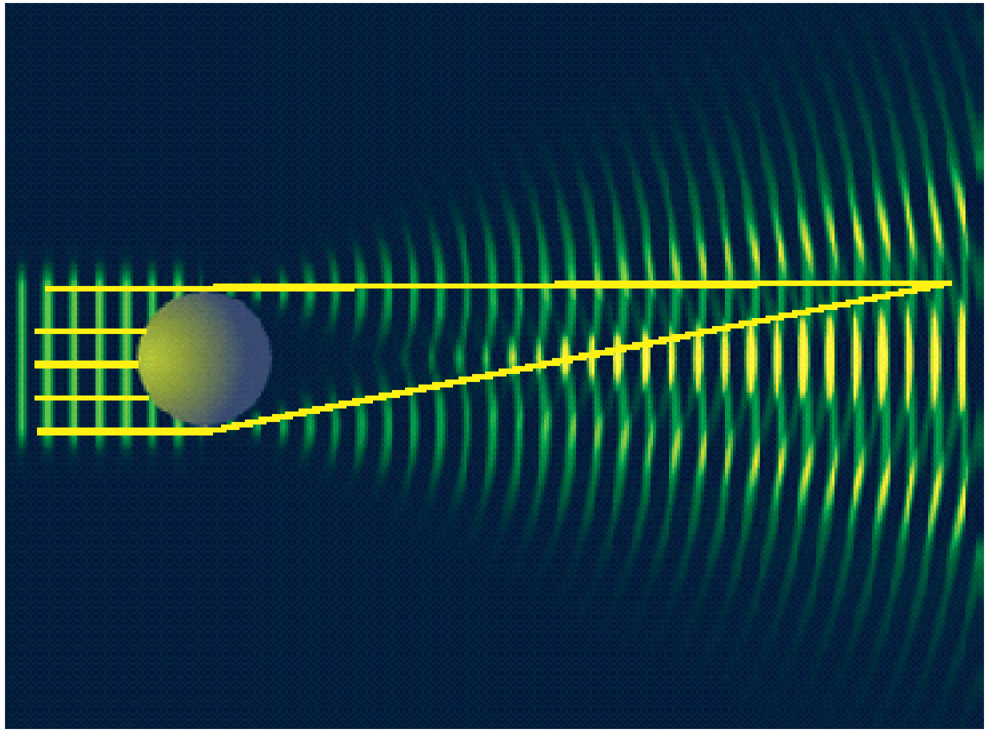

One size
10%
20%

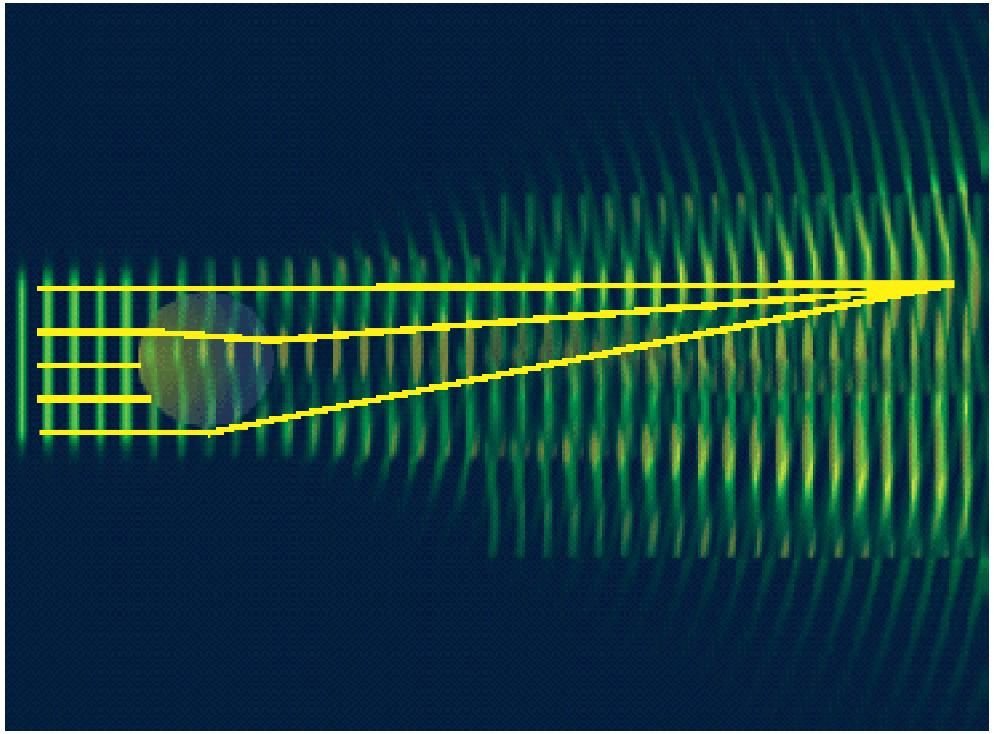
uklon na okrogli luknji - Airyjev disk

- https://phet.colorado.edu/sims/html/wave-interference/latest/wave-interference_en.html



https://sl.wikipedia.org/wiki/Airyjev_disk





miejevo sipanje

$$\nabla^2\mathbf{E} + k^2\mathbf{E} = 0, \quad \nabla^2\mathbf{H} + k^2\mathbf{H} = 0.$$

In addition to the Helmholtz equation, the fields must satisfy the conditions $\nabla \cdot \mathbf{E} = \nabla \cdot \mathbf{H} = 0$ and $\nabla \times \mathbf{E} = i\omega\mu\mathbf{H}$, $\nabla \times \mathbf{H} = -i\omega\varepsilon\mathbf{E}$. Vector spherical harmonics possess all the necessary properties, introduced as follows:

$$\mathbf{M}_{\substack{e\\o}mn} = \nabla \times \left(\mathbf{r}\psi_{\substack{e\\o}mn}\right) \text{ — magnetic harmonics (TE),}$$

$$\mathbf{N}_{\substack{e\\o}mn} = \frac{\nabla \times \mathbf{M}_{\substack{e\\o}mn}}{k} \text{ — electric harmonics (TM),}$$

where

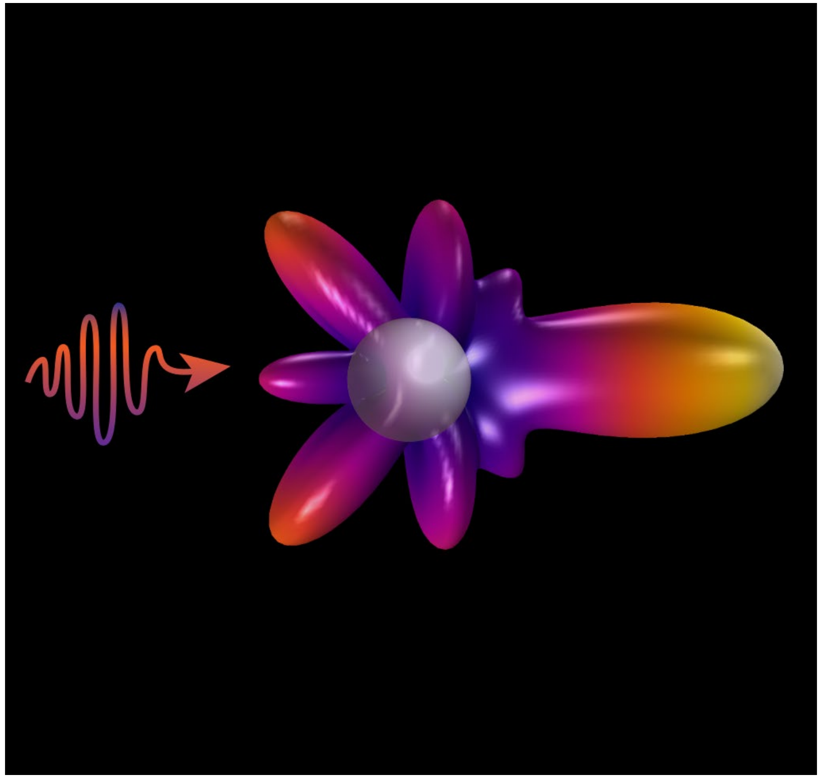
$$\psi_{emn} = \cos m\varphi P_n^m(\cos\vartheta) z_n(kr),$$
$$\psi_{omn} = \sin m\varphi P_n^m(\cos\vartheta) z_n(kr),$$

and $P_n^m(\cos\theta)$ — Associated Legendre polynomials, and $z_n(kr)$ — any of the spherical Bessel functions.

Next, we expand the incident plane wave in vector spherical harmonics:

$$\mathbf{E}_{inc} = E_0 e^{ikr\cos\theta}\mathbf{e}_x = E_0 \sum_{n=1}^{\infty} i^n \frac{2n+1}{n(n+1)} \left(\mathbf{M}_{o1n}^{(1)}(k,\mathbf{r}) - i\mathbf{N}_{e1n}^{(1)}(k,\mathbf{r})\right),$$

$$\mathbf{H}_{inc} = \frac{-k}{\omega\mu} E_0 \sum_{n=1}^{\infty} i^n \frac{2n+1}{n(n+1)} \left(\mathbf{M}_{e1n}^{(1)}(k,\mathbf{r}) + i\mathbf{N}_{o1n}^{(1)}(k,\mathbf{r})\right).$$



https://en.wikipedia.org/wiki/Codes_for_electromagnetic_scattering_by_spheres

https://en.wikipedia.org/wiki/Atmospheric_radiative_transfer_codes

https://en.wikipedia.org/wiki/Mie_scattering

Scattered fields are written in terms of a vector harmonic expansion as

$$\mathbf{E}_s = \sum_{n=1}^{\infty} E_n \left(i a_n \mathbf{N}_{e1n}^{(3)}(k, \mathbf{r}) - b_n \mathbf{M}_{o1n}^{(3)}(k, \mathbf{r}) \right),$$

$$\mathbf{H}_s = \frac{k}{\omega\mu} \sum_{n=1}^{\infty} E_n \left(a_n \mathbf{M}_{e1n}^{(3)}(k, \mathbf{r}) + i b_n \mathbf{N}_{o1n}^{(3)}(k, \mathbf{r}) \right).$$

Here the superscript (3) means that in the radial part of the functions $\psi_{^e_omn}$ are spherical Hankel functions of the first kind (those of the second kind would have (4)), and $E_n = \dfrac{i^n E_0 (2n+1)}{n(n+1)}$,

Internal fields:

$$\mathbf{E}_1 = \sum_{n=1}^{\infty} E_n \left(-i d_n \mathbf{N}_{e1n}^{(1)}(k_1, \mathbf{r}) + c_n \mathbf{M}_{o1n}^{(1)}(k_1, \mathbf{r}) \right),$$

$$\mathbf{H}_1 = \frac{-k_1}{\omega\mu_1} \sum_{n=1}^{\infty} E_n \left(d_n \mathbf{M}_{e1n}^{(1)}(k_1, \mathbf{r}) + i c_n \mathbf{N}_{o1n}^{(1)}(k_1, \mathbf{r}) \right).$$

After applying the interface conditions, we obtain expressions for the coefficients:

$$c_n(\omega) = \frac{\mu_1 [\rho h_n(\rho)]' j_n(\rho) - \mu_1 [\rho j_n(\rho)]' h_n(\rho)}{\mu_1 [\rho h_n(\rho)]' j_n(\rho_1) - \mu [\rho_1 j_n(\rho_1)]' h_n(\rho)},$$

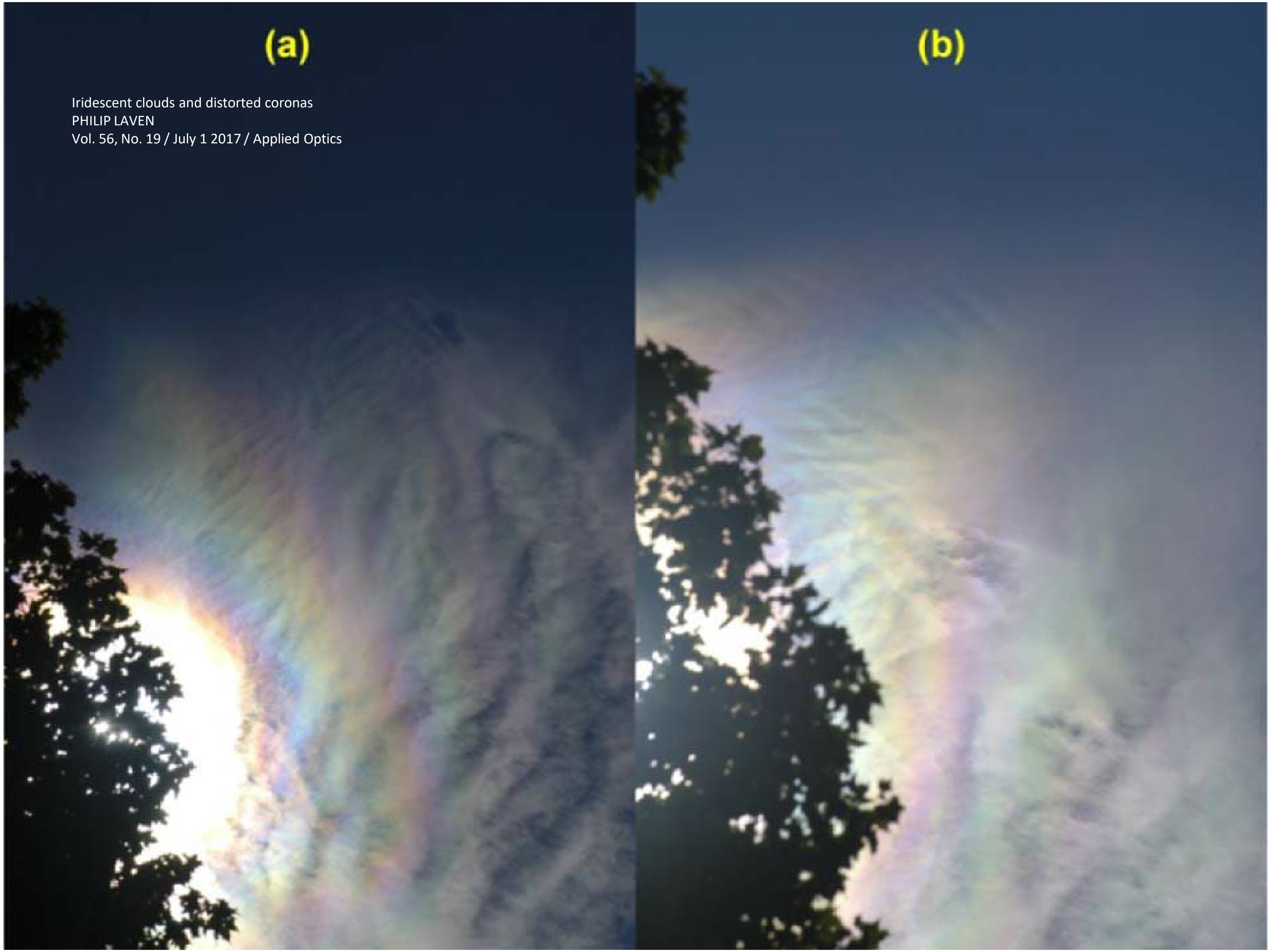
$$d_n(\omega) = \frac{\mu_1 n_1 n [\rho h_n(\rho)]' j_n(\rho) - \mu_1 n_1 n [\rho j_n(\rho)]' h_n(\rho)}{\mu n_1^2 [\rho h_n(\rho)]' j_n(\rho_1) - \mu_1 n^2 [\rho_1 j_n(\rho_1)]' h_n(\rho)},$$

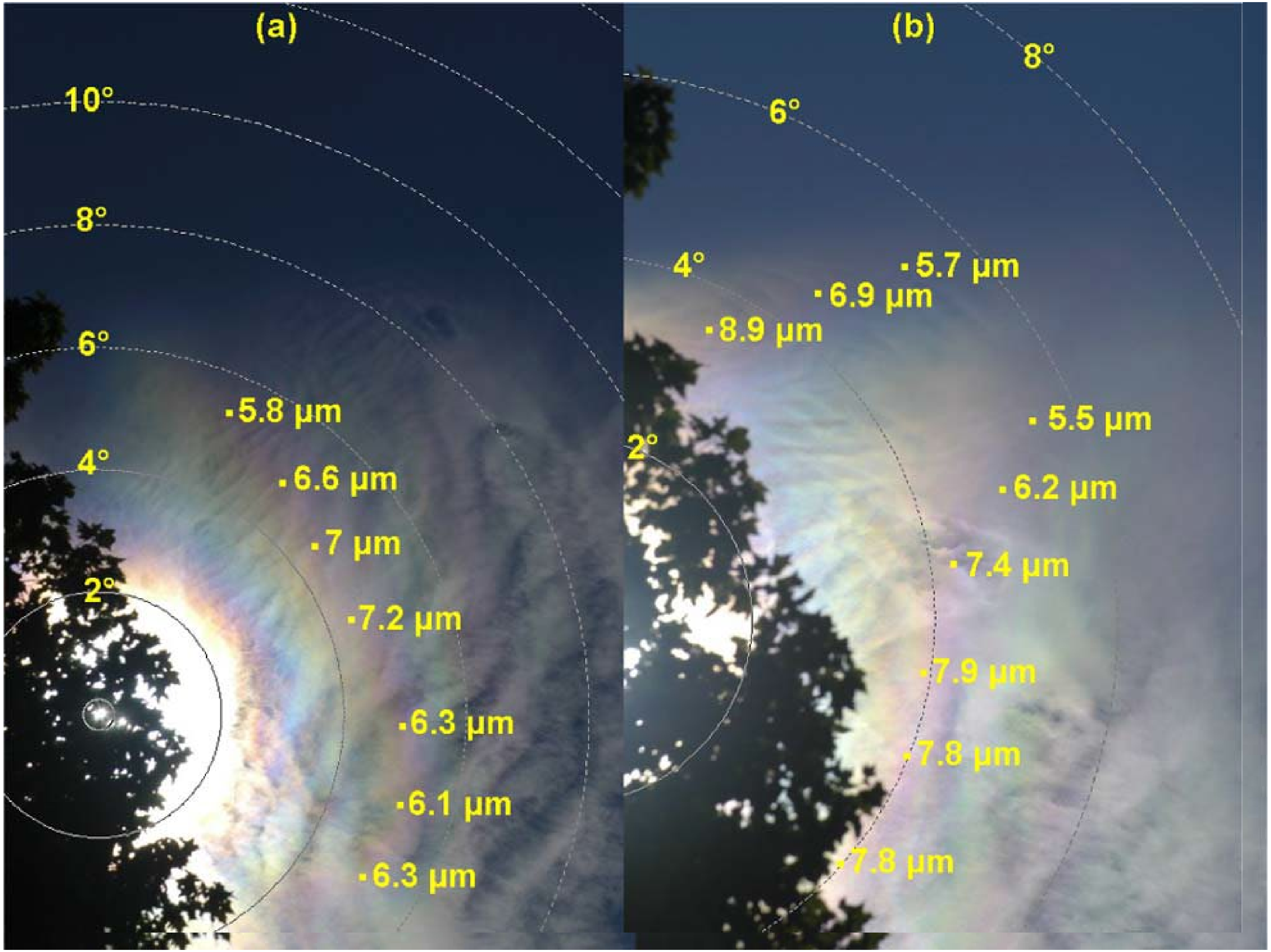
$$b_n(\omega) = \frac{\mu_1 [\rho j_n(\rho)]' j_n(\rho_1) - \mu [\rho_1 j_n(\rho_1)]' j_n(\rho)}{\mu_1 [\rho h_n(\rho)]' j_n(\rho_1) - \mu [\rho_1 j_n(\rho_1)]' h_n(\rho)},$$

$$a_n(\omega) = \frac{\mu n_1^2 [\rho j_n(\rho)]' j_n(\rho_1) - \mu_1 n^2 [\rho_1 j_n(\rho_1)]' j_n(\rho)}{\mu n_1^2 [\rho h_n(\rho)]' j_n(\rho_1) - \mu_1 n^2 [\rho_1 j_n(\rho_1)]' h_n(\rho)},$$

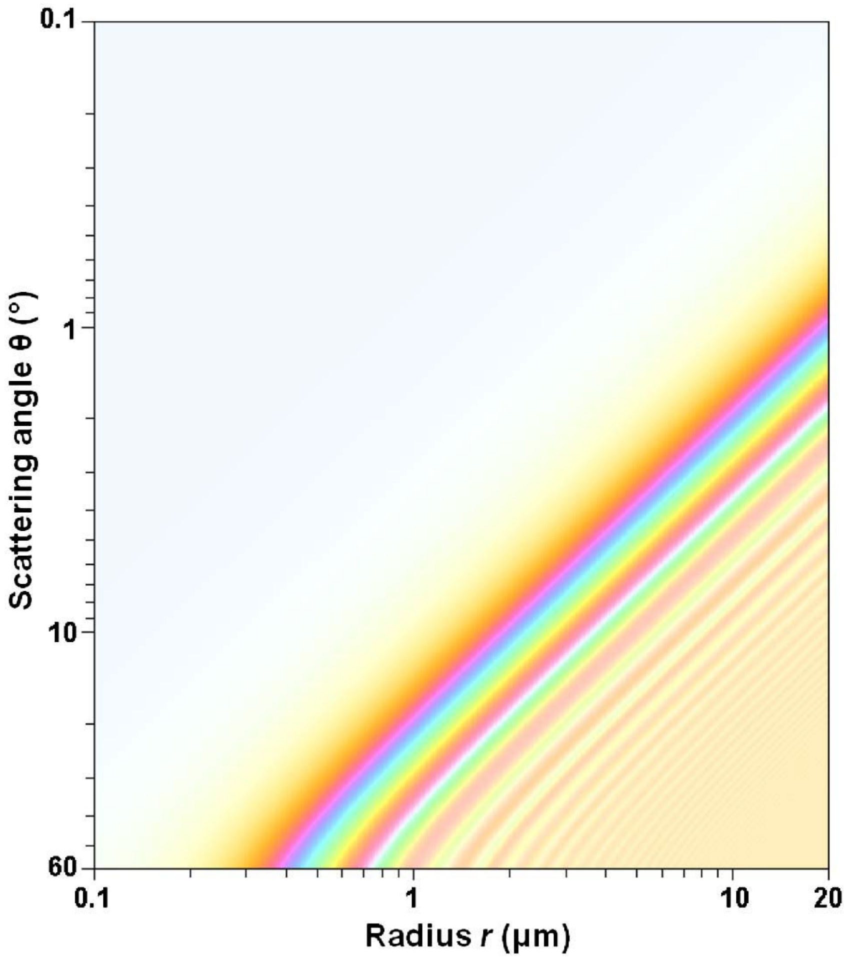
iridiscenca oblakov

https://en.wikipedia.org/wiki/Cloud_iridescence

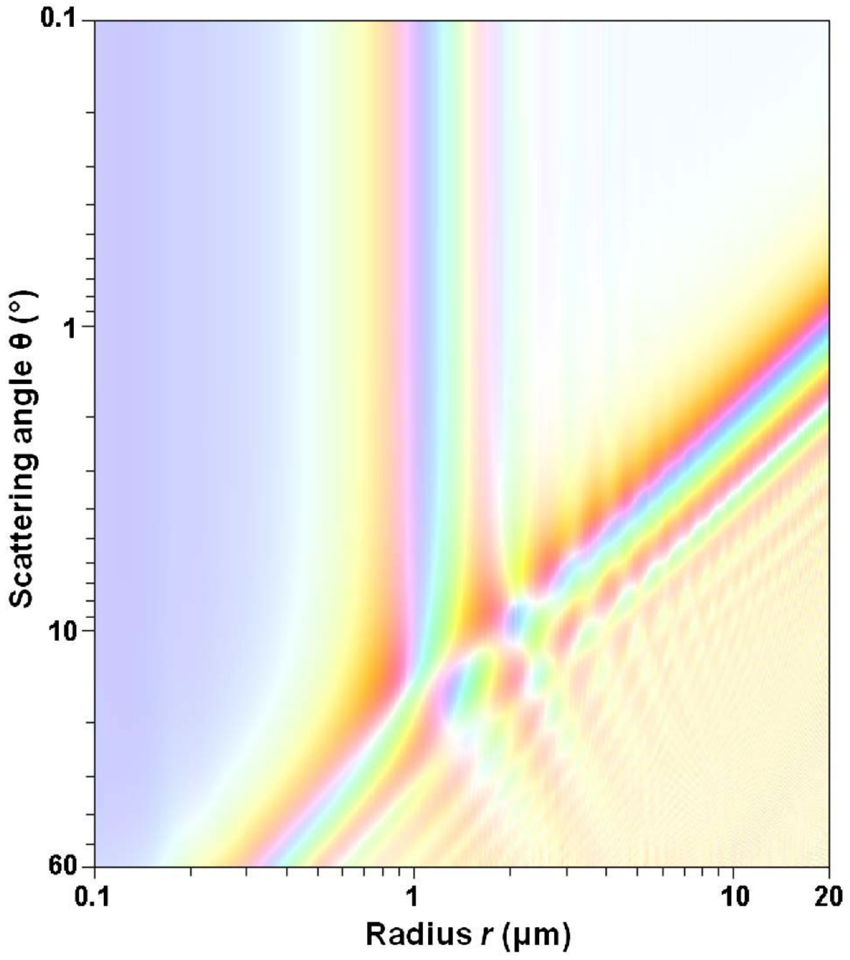

(a)
Iridescent clouds and distorted coronas
PHILIP LAVEN
Vol. 56, No. 19 / July 1 2017 / Applied Optics
(b)



(a)
10°
8°
6°
4°
2°
5.8 µm
6.6 µm
7 µm
7.2 µm
6.3 µm
6.1 µm
6.3 µm
(b)
8°
6°
4°
2°
5.7 µm
6.9 µm
8.9 µm
5.5 µm
6.2 µm
7.4 µm
7.9 µm
7.8 µm
7.8 µm


0.1
1
10
60
Scattering angle θ (°)
0.1
1
10
20
Radius r (μm)

uklon


0.1
1
10
60
Scattering angle θ (°)
0.1
1
10
20
Radius r (μm)

mie