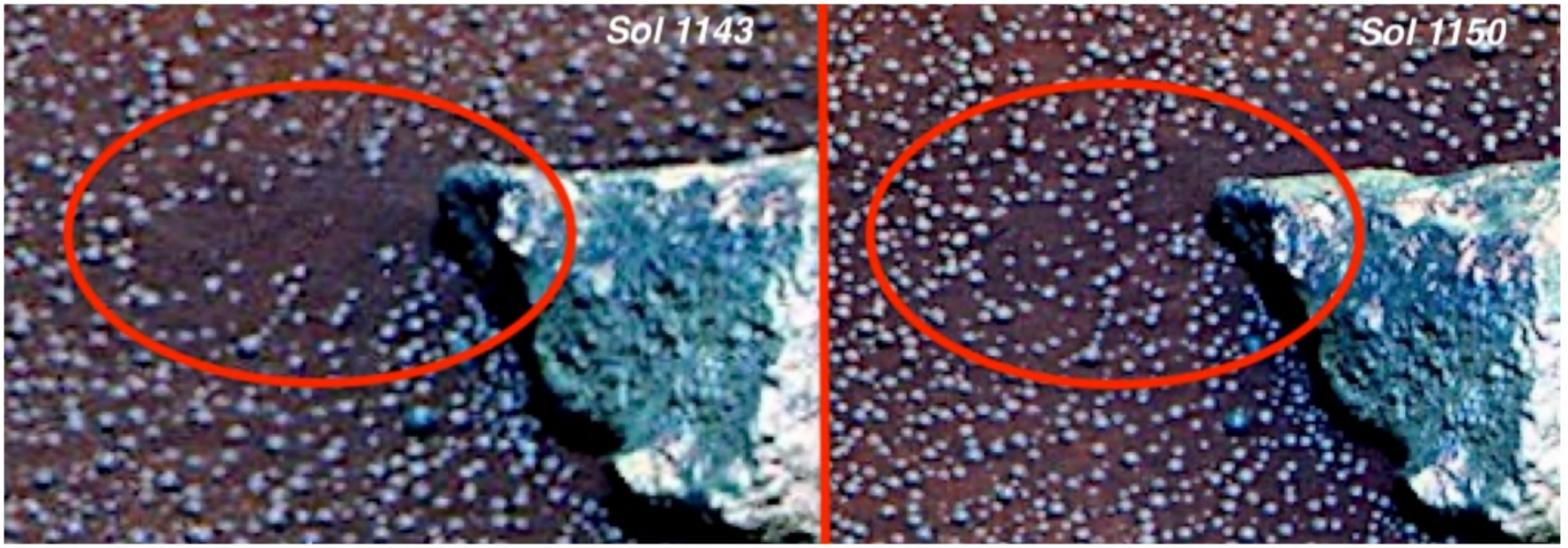
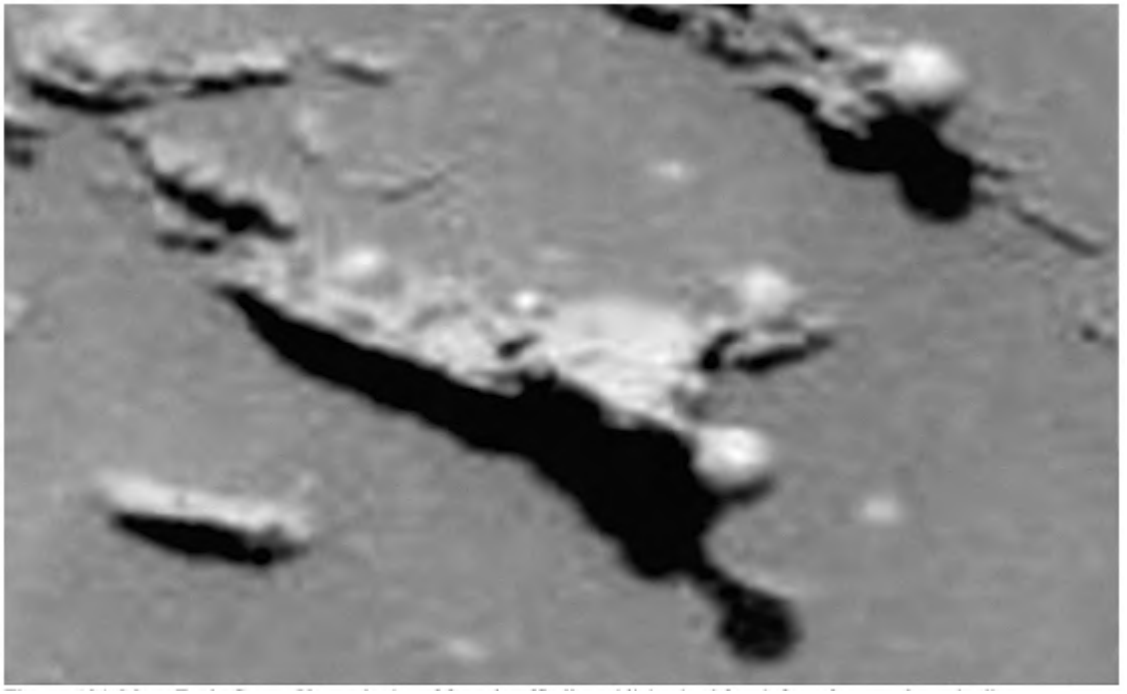
R. Gabriel Joseph, Astrobiology Research Center, CA, USA



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# Growth of Cyanobacteria in Gale Crater, Mars, Based on Sequential Images

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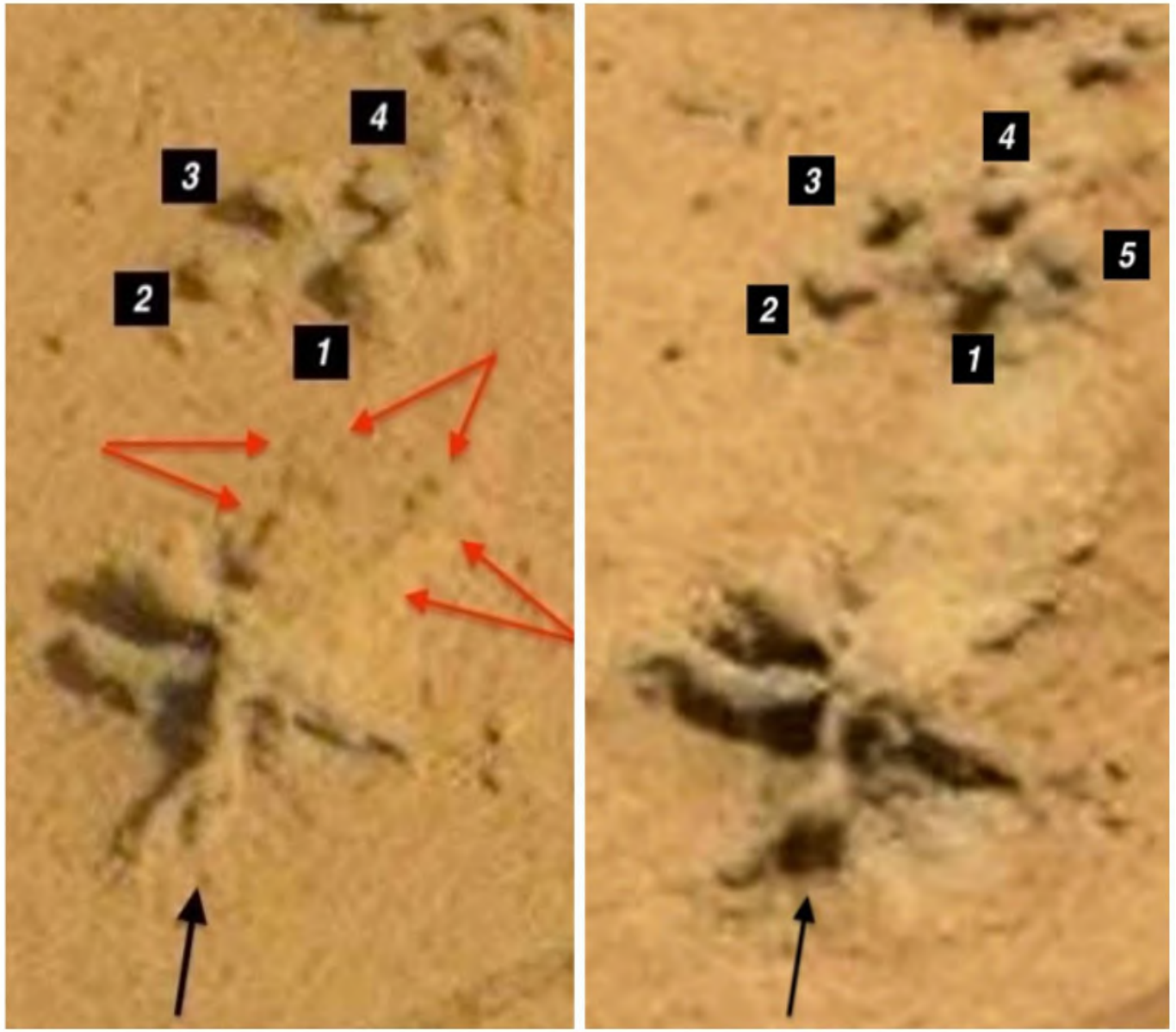
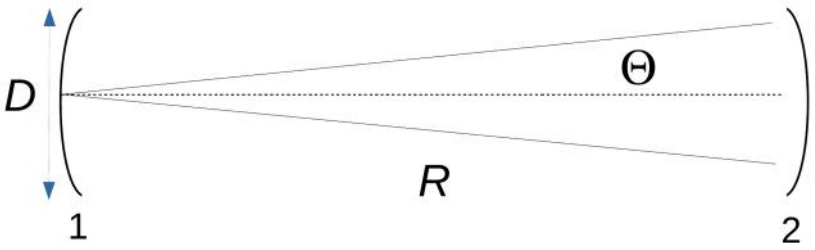



Photographed by Curiosity's Micro-Imager Camera in Gale Crater, Mars.

Sol 0753 — Sol 0758

# Предельные расстояния связи и обнаружения




$$\Theta \sim \lambda / D$$

$$\Omega_\Theta = \pi \Theta^2 = \pi (\lambda / D)^2$$

$$g_1 = \frac{4\pi}{\Omega_\Theta} = \frac{4D^2}{\lambda^2} = \frac{16 S_1}{\pi \lambda^2}$$

$$P_2 = S_2 \frac{g_1 P_1}{4\pi R^2} = \frac{4 S_1 S_2 P_1}{\pi^2 \lambda^2 R^2}$$

$$P_{ns} = k T_{ns} \Delta f$$

$$\alpha = \frac{P_2}{P_{ns}} = \frac{4 S_1 S_2 P_1}{\pi^2 \lambda^2 R^2} \frac{1}{k T_{ns} \Delta f}$$

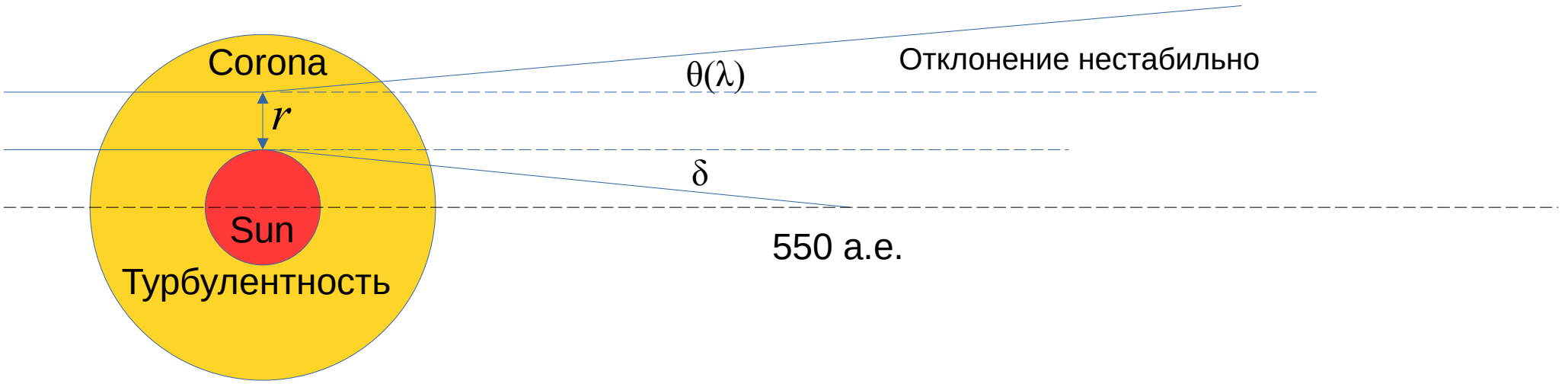
$$R = \sqrt{\frac{4 S_1 S_2 P_1}{\alpha \pi^2 \lambda^2} \frac{1}{k T_{ns} \Delta f}}$$

- $\alpha \sim 1$ – уверенный обмен информацией
- $\alpha \ll 1$ – обнаружение несущей

Аресибский планетный радар:
$S_1 = S_2 = 10^5$ м$^2$;
$P_1 = 10^6$ Вт;
$\lambda = 3$ см;
$\Delta f = 1$ Гц;
$T_{ns} = 10$ K$^o$
$\alpha = 1 \Rightarrow$
$R = 19100$ св. лет

Аэродромный/военный радар:
$S_1 = 10^2$ м$^2$; $S_2 = 10^5$ м$^2$;
$P_1 = 5 \times 10^4$ Вт;
$\lambda = 3$ см;
$\Delta f = 1000$ Гц;
$T_{ns} = 10$ K$^o$
$\alpha = 1 \Rightarrow$
$R = 4.3$ св. лет

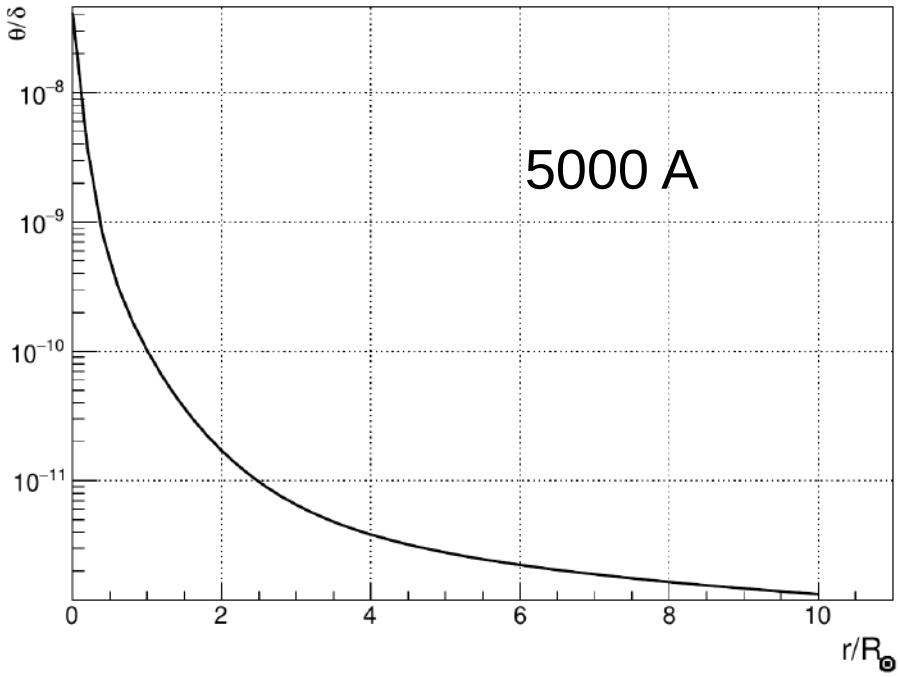
***Обнаружение***
$\alpha \sim 0.01$
$R$ = 43 св. лет
$S_2 = 10^9$ м$^2$,
$D_2$ = 30 км
$R$ = 4300 св. лет

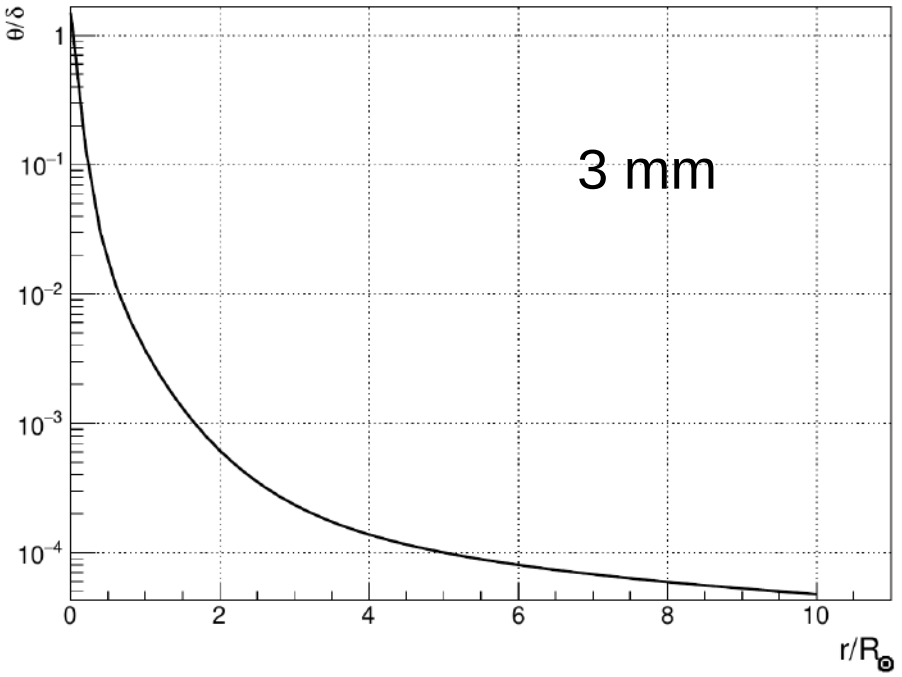


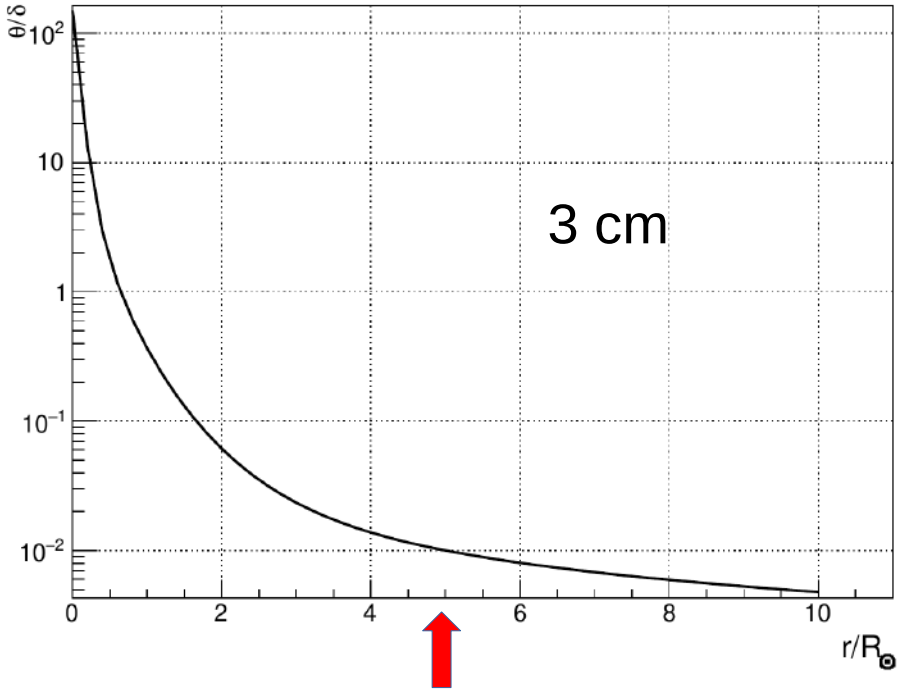

$$b = 1 + \frac{r}{R_\odot} \qquad \delta = 2\,\frac{R_g}{R_\odot}\,\frac{1}{b}$$

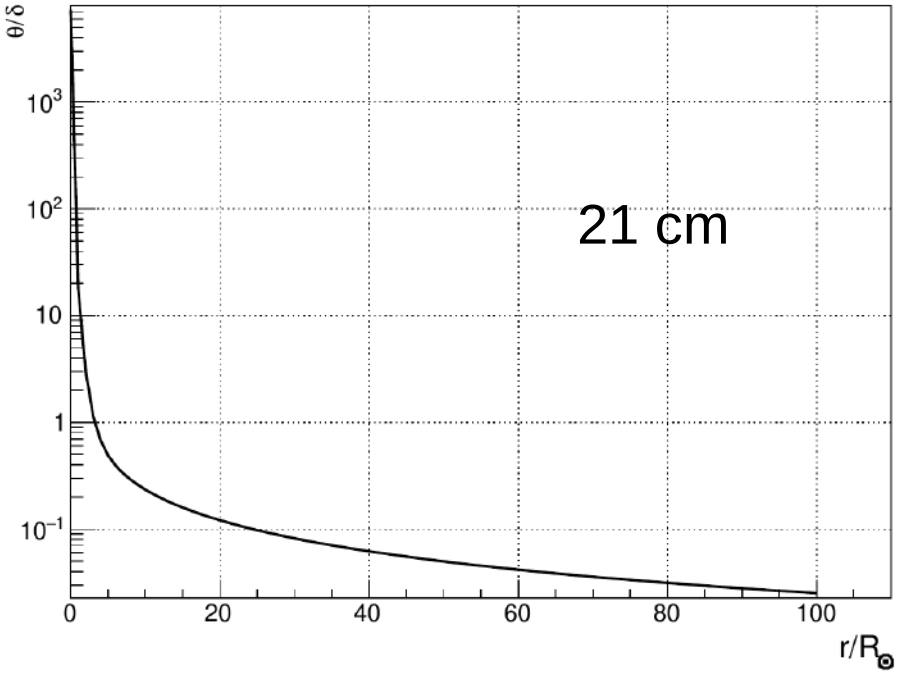
$$\theta = \left(\frac{6.32\,\mathrm{MHz}}{\nu}\right)^2 \left(\frac{2.952 \cdot 10^3}{b^{16}} + \frac{2.28 \cdot 10^2}{b^6} + \frac{1.1}{b^2}\right)$$

$$\frac{\theta}{\delta} \propto \frac{1}{b}$$


θ/δ
$10^{-8}$
$10^{-9}$
$10^{-10}$
$10^{-11}$
0
2
4
6
8
10
r/R⊙
5000 A


θ/δ
1
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
0
2
4
6
8
10
r/R⊙
3 mm


θ/δ
$10^{2}$
10
1
$10^{-1}$
$10^{-2}$
0
2
4
6
8
10
r/R⊙
3 cm


θ/δ
$10^{3}$
$10^{2}$
10
1
$10^{-1}$
0
20
40
60
80
100
r/R⊙
21 cm

Гравитоскоп на волну $\lambda = 3\,\text{см}$
$r/R_\odot = 5$
$\theta/\delta = 0.01$
$L \approx 20000$ а.е. $= 110$ св. дней
$D_{\text{экв}} = 260$ км для диаметра антенны $4\,\text{м}$.
Для скорости $1/40\,c$ время полета в фокус $12\,\text{лет}$

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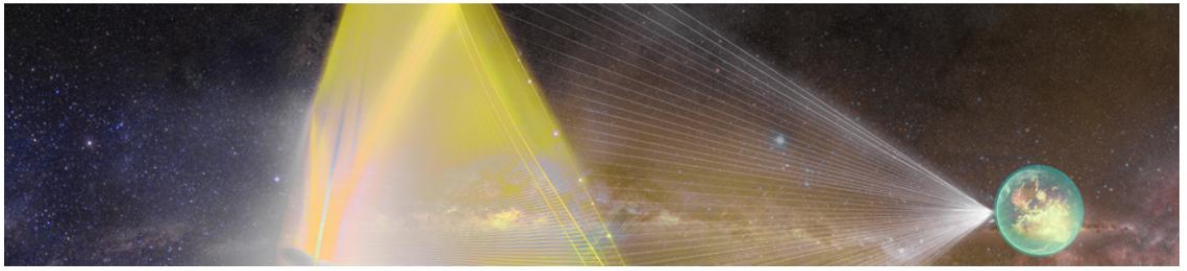
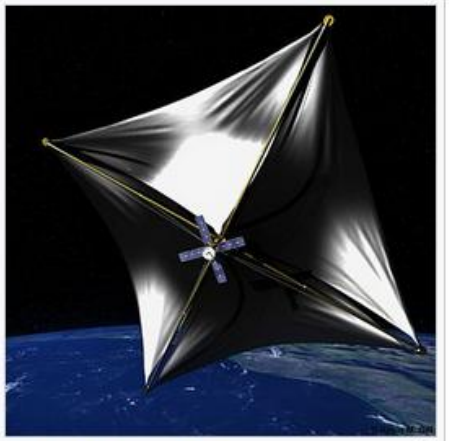


Юрий Мильнер

## Concept [edit]

The Starshot concept envisions launching a "mothership" carrying about a thousand tiny spacecraft (on the scale of centimeters) to a high-altitude Earth orbit for deployment. A phased array of ground-based lasers would then focus a light beam on the crafts' sails to accelerate them one by one to the target speed within 10 minutes, with an average acceleration on the order of 100 km/s$^2$ (10,000 g), and an illumination energy on the order of 1 TJ delivered to each sail. A preliminary sail model is suggested to have a surface area of 4 m × 4 m.[19][20] An October 2017 presentation of the Starshot system model[21][22] examined circular sails and finds that the beam director capital cost is minimized by having a sail diameter of 5 meters.

The Earth-sized planet Proxima Centauri b is within the Alpha Centauri system's habitable zone. Ideally, the Breakthrough Starshot would aim its spacecraft within one astronomical unit (150 million kilometers or 93 million miles) of that world. From this distance, a craft's cameras could capture an image of high enough resolution to resolve surface features.[23]



A solar sail concept