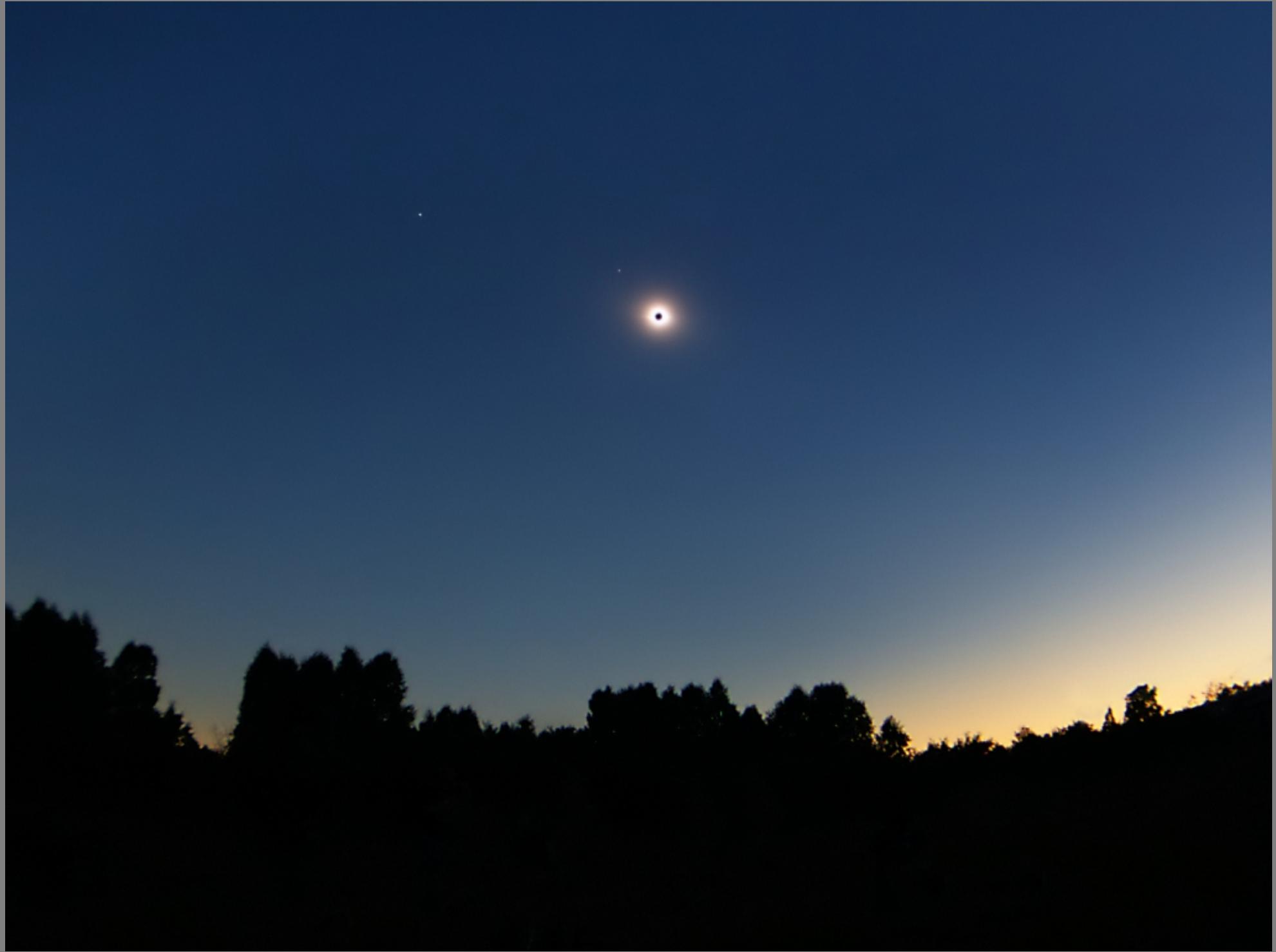


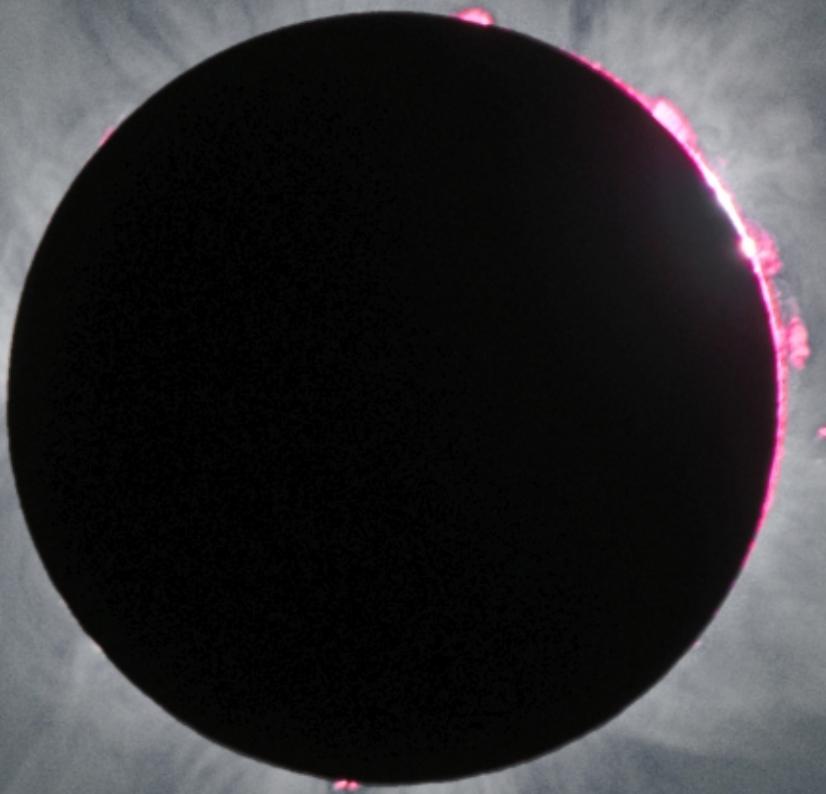
Úplná zatmění Slunce a vyřešené i nevyřešené záhady sluneční koróny



Miloslav Druckmüller, FSI VUT Brno



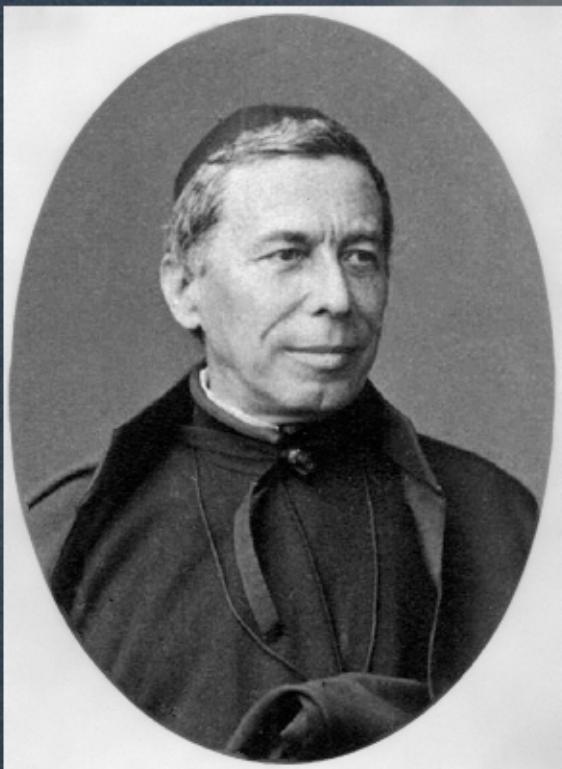
Zlatá éra pozorování zatmění Slunce



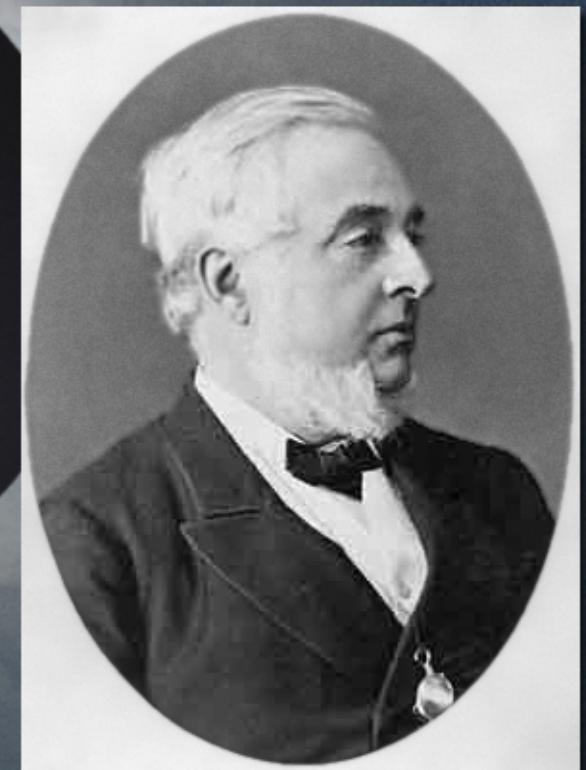
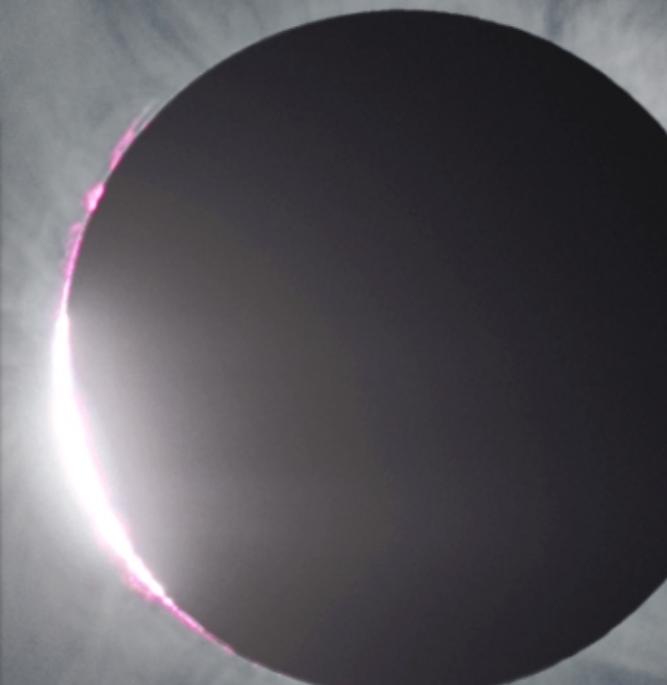
18. 7. 1860 - 11. 7. 1991

Španělsko, 18. 7. 1860

Vyřešení problému protuberancí



Angelo Secchi



Warren de la Rue

Bezštěrbinový spektrograf

Charles Augustus Young

První úspěšné využití difrakční mřížky v astronomii



0. řád



1. řád



400 nm

700 nm



400 nm

700 nm

2. řád



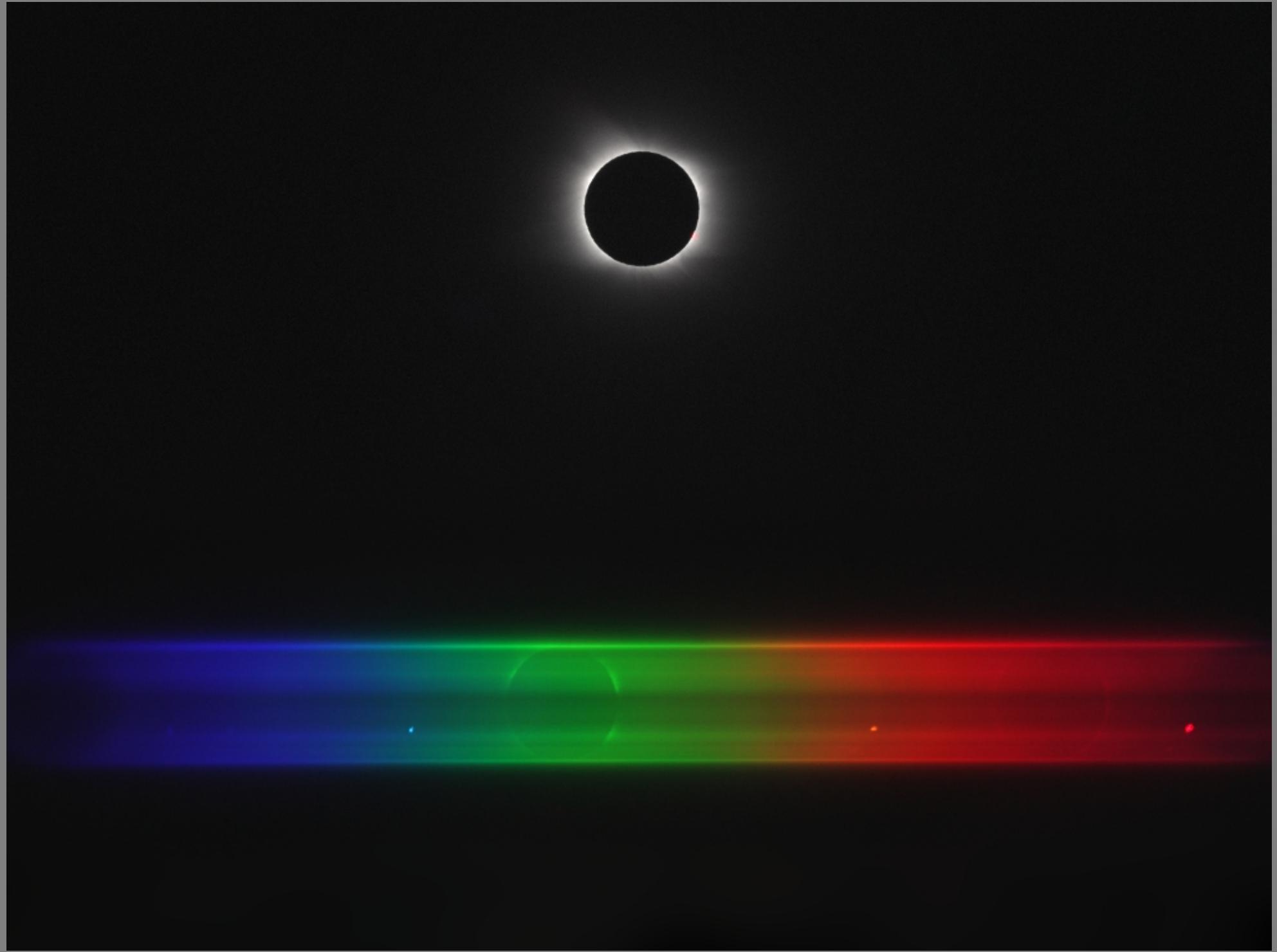
400 nm

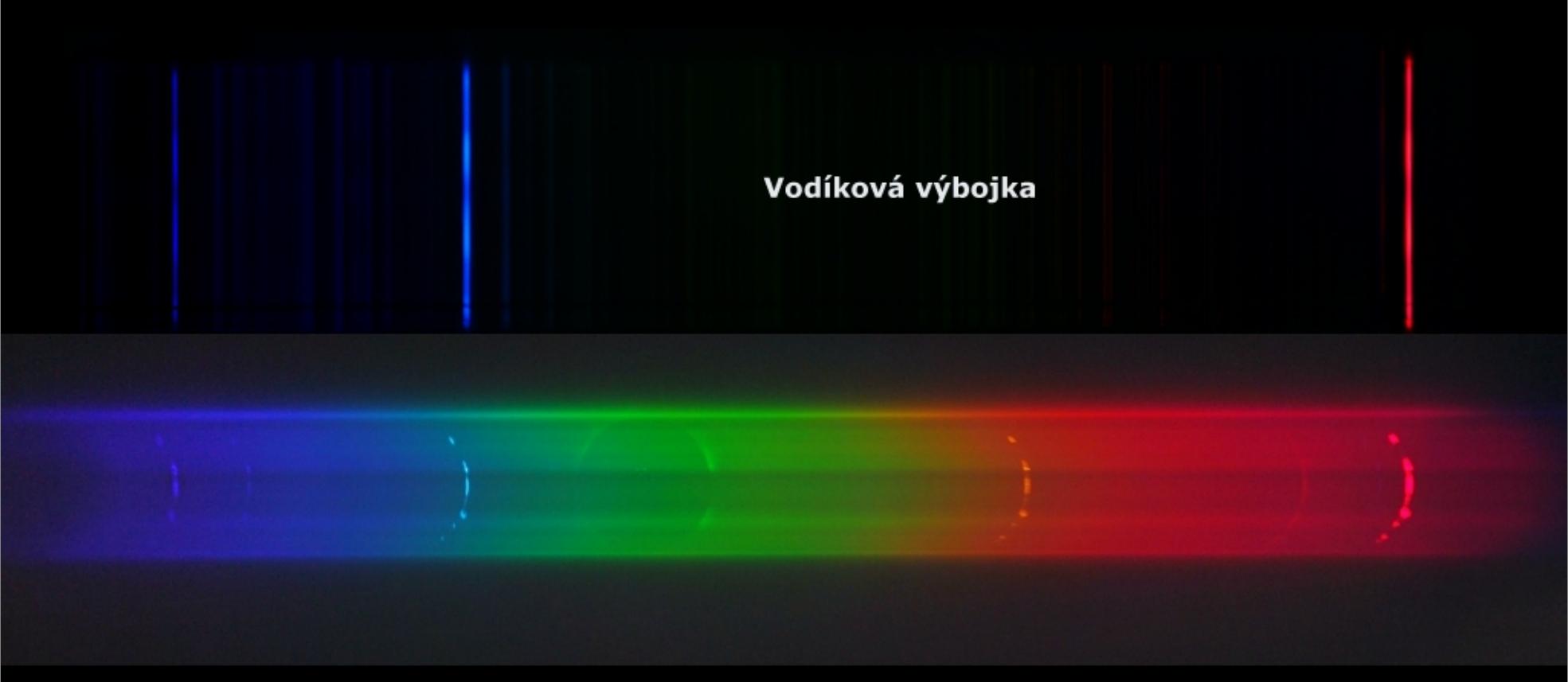
700 nm



400 nm

700 nm



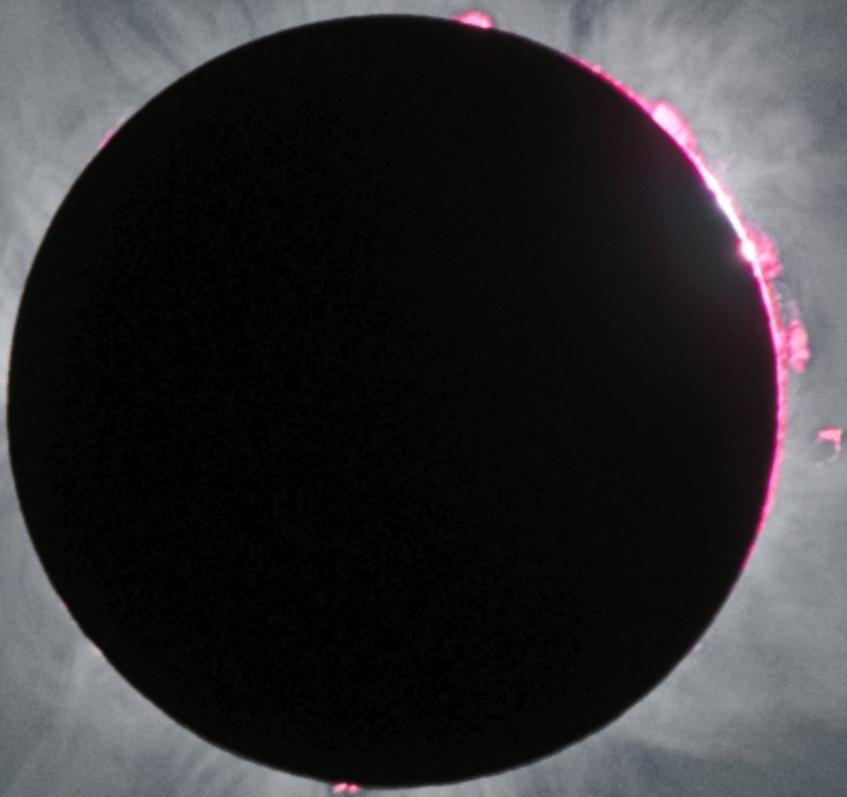
A photograph of a hydrogen spectral line source. It shows a dark background with several vertical colored bands of light. A prominent blue band is at the top left, followed by green, yellow, orange, and red bands. Above the spectrum, the text "Vodíková výbojka" is written in white.

Vodíková výbojka

18. 8. 1868

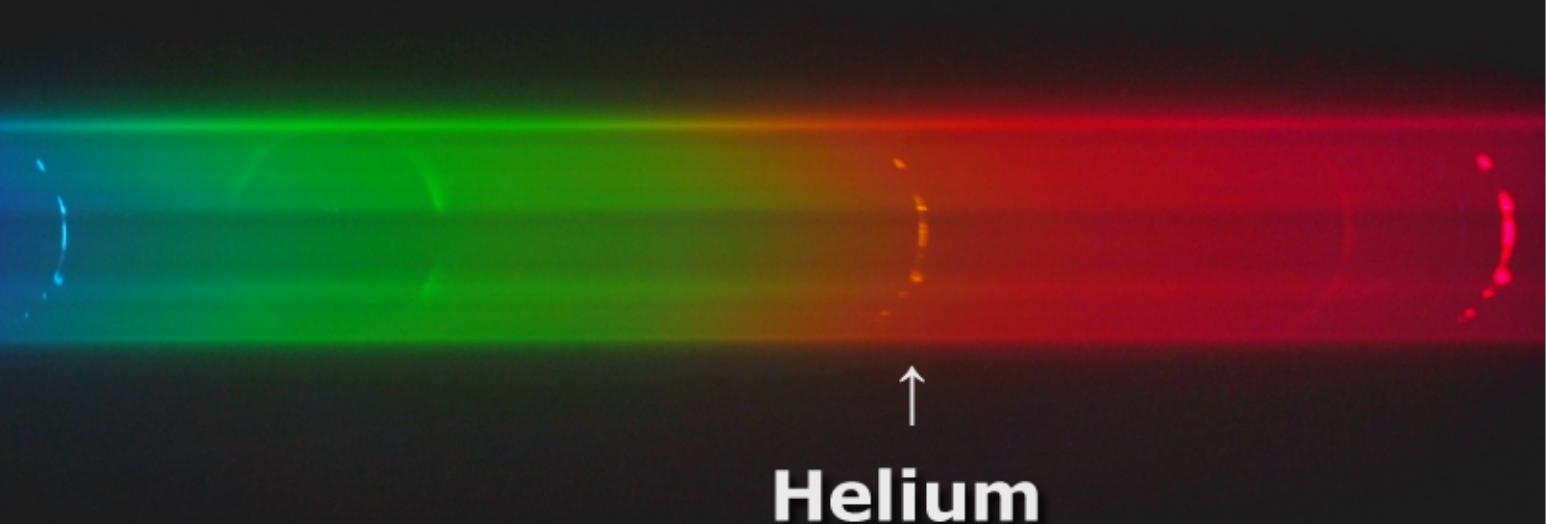
Dominantním prvkem v protuberancích a chromosféře je vodík

James Francis Tennant, John Herschel, Jules Janssen, Georges Rayet, Norman Pogson



18. 8. 1868

J. Norman Lockyer

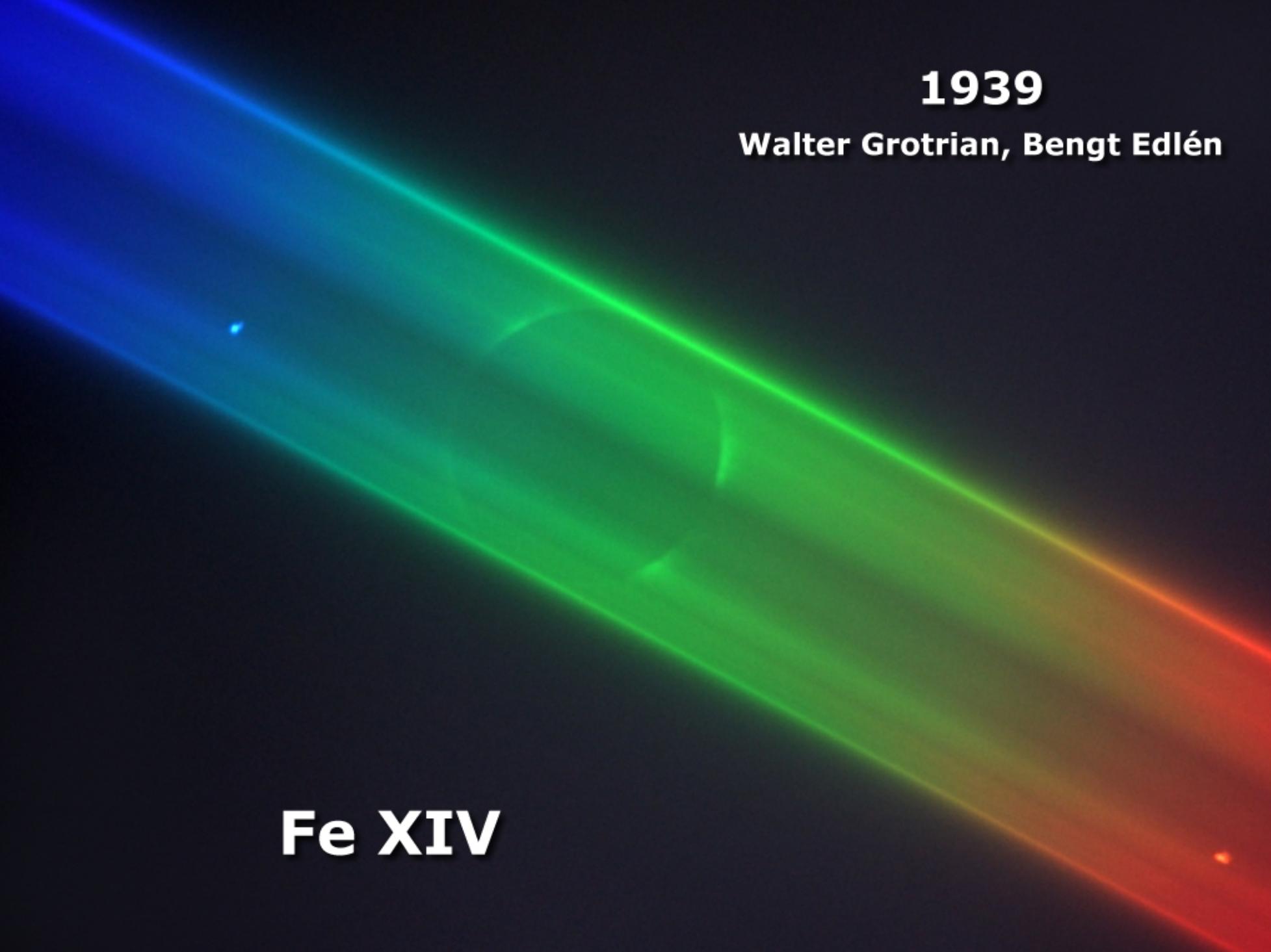




7. 8. 1869

**Charles Augustus Young
William Harkness**

Záhadné coronium



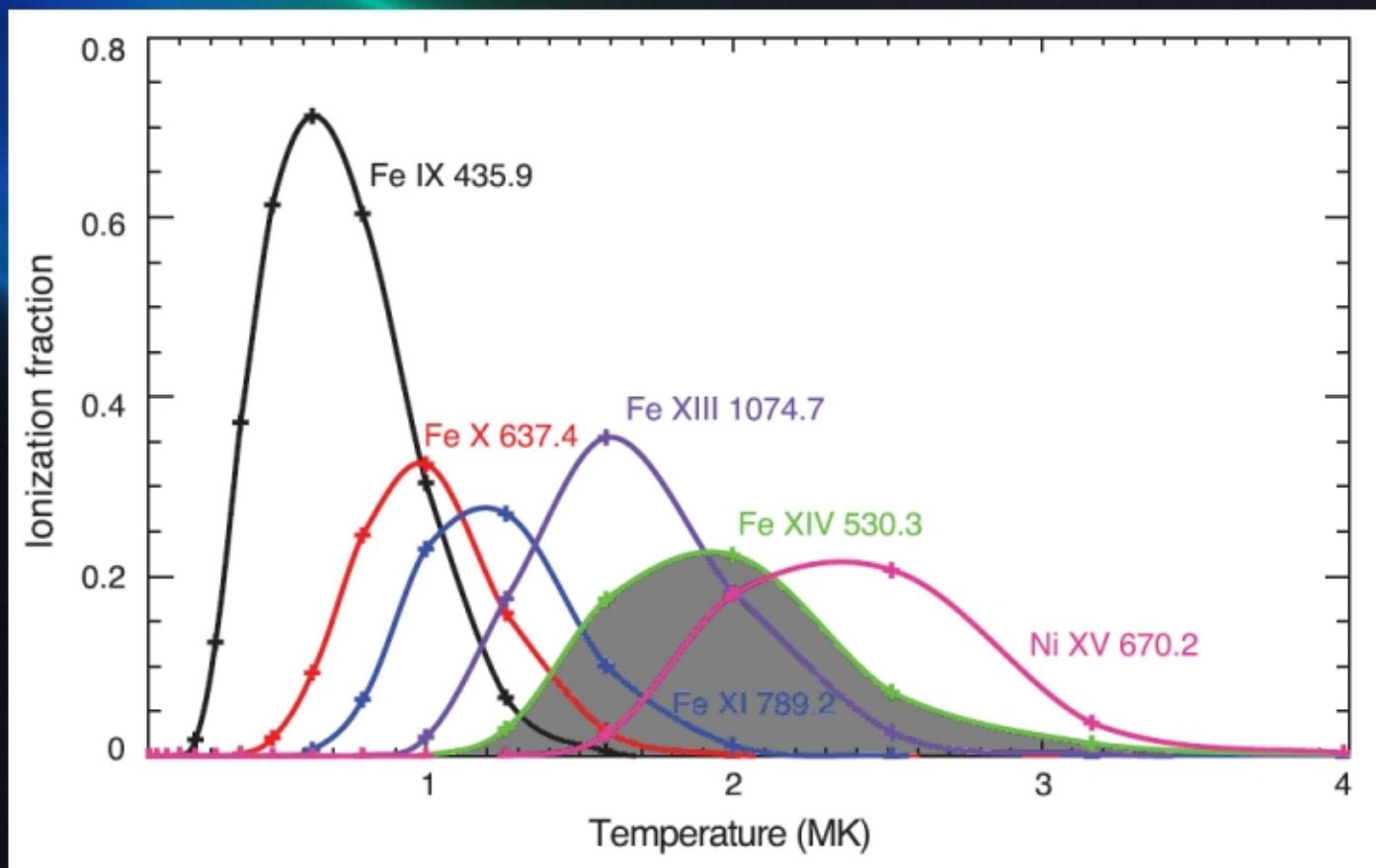
1939

Walter Grotrian, Bengt Edlén

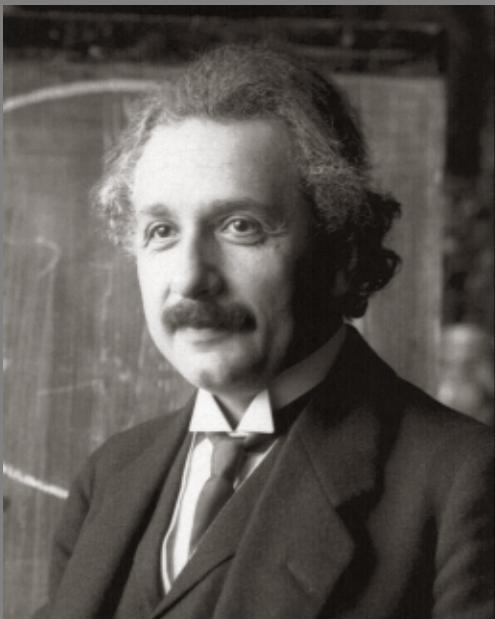
Fe XIV

1939

Walter Grotrian, Bengt Edlén



Fe XIV

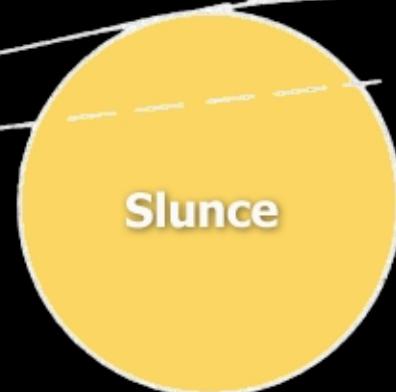


Albert Einstein



Země

1,75''



★
hvězda



29. 5. 1919

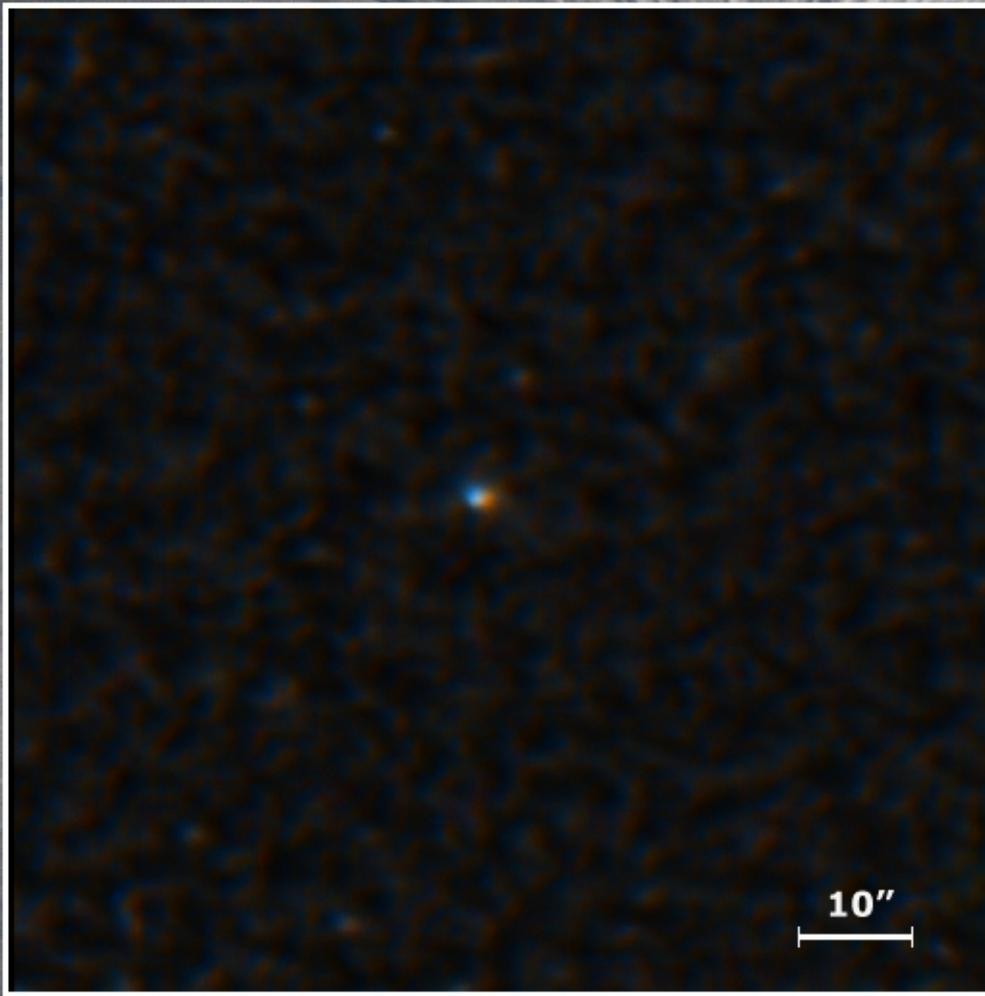
29. 5. 1919

Obecná teorie relativity



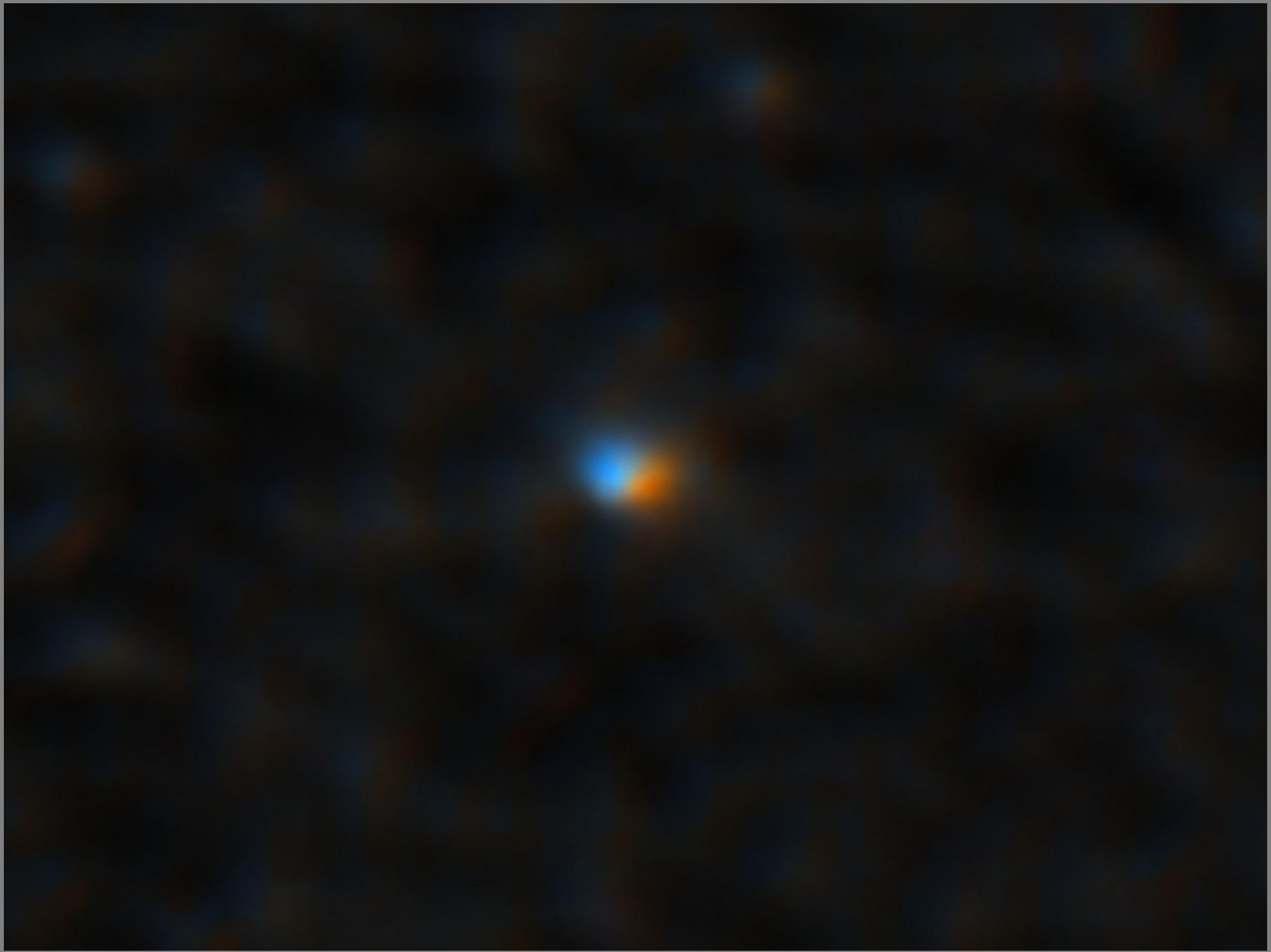
Arthur Eddington





10''

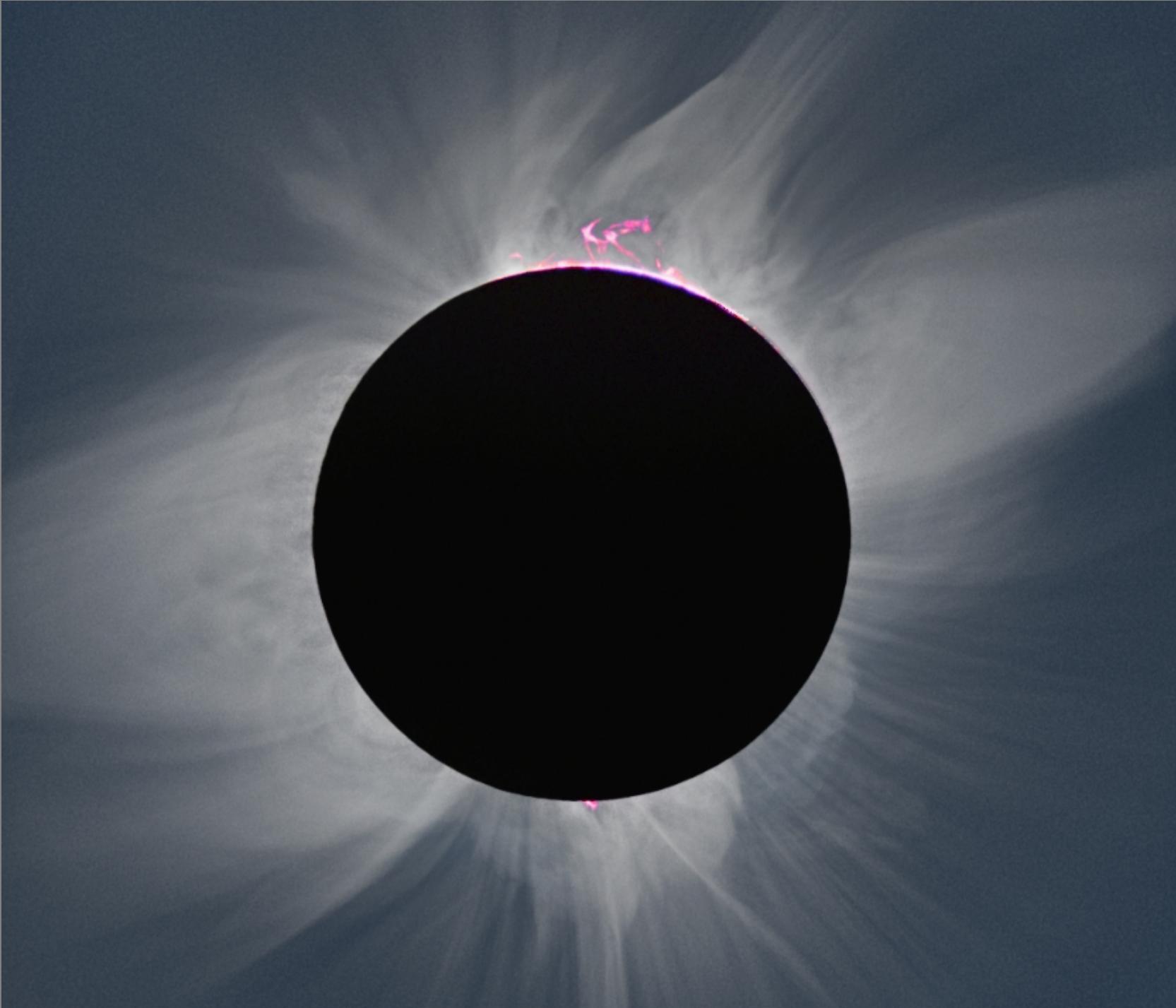




„Great Hawaiian Eclipse“

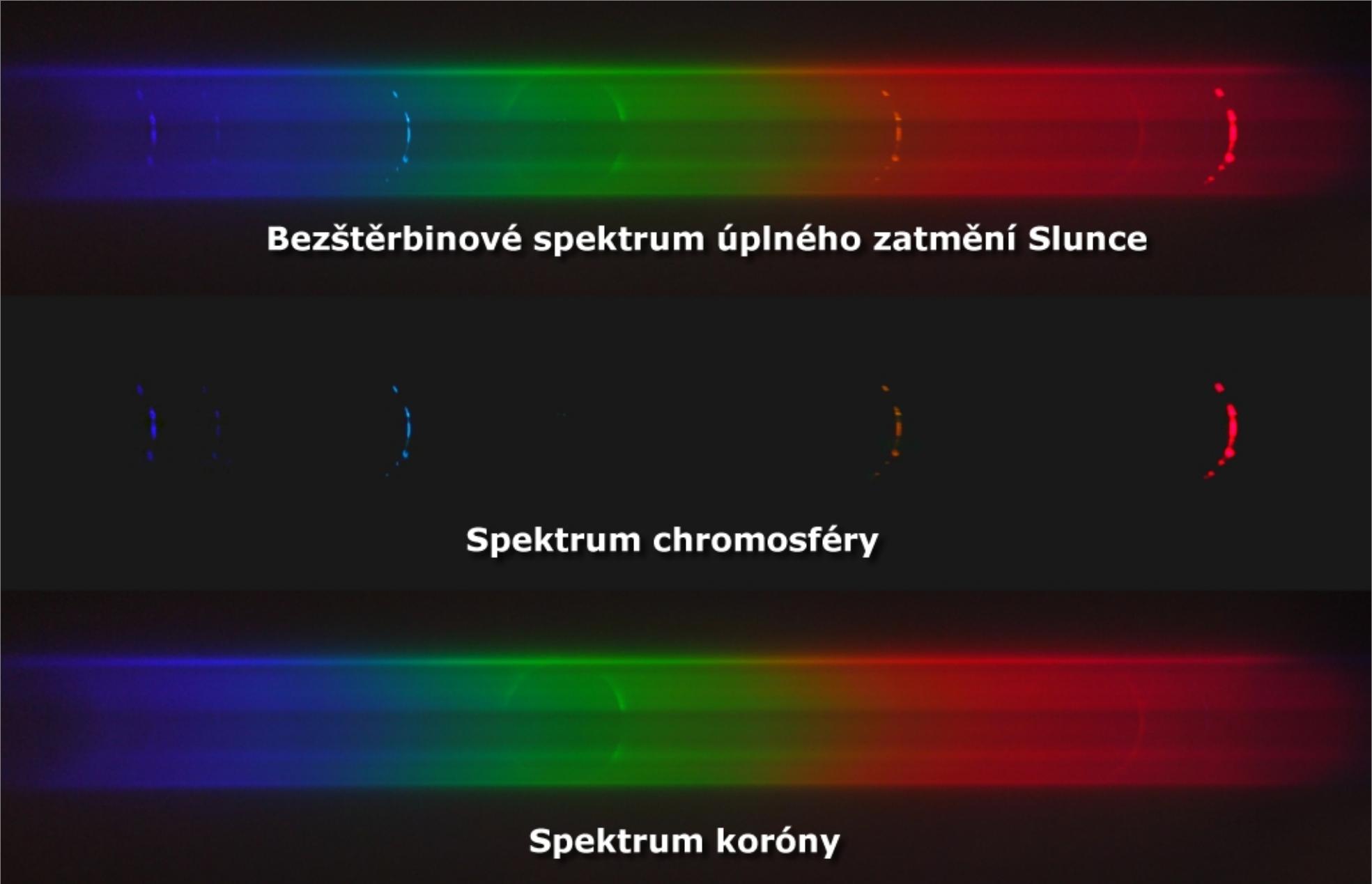


11. 7. 1991



Konec zlaté éry pozorování zatmění Slunce





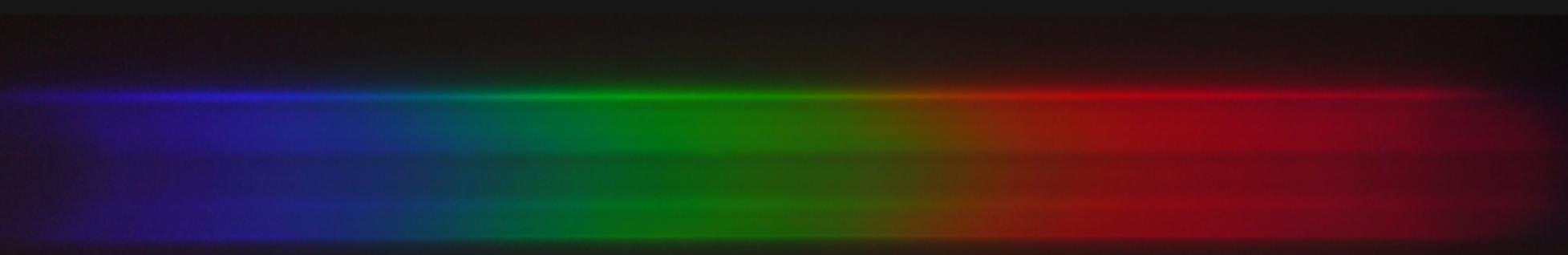
Bezštěrbinové spektrum úplného zatmění Slunce

Spektrum chromosféry

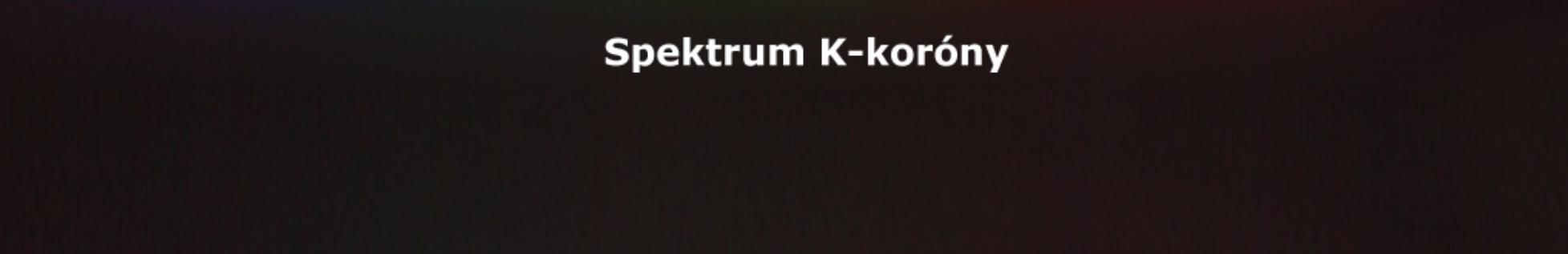
Spektrum koróny



Spektrum koróny

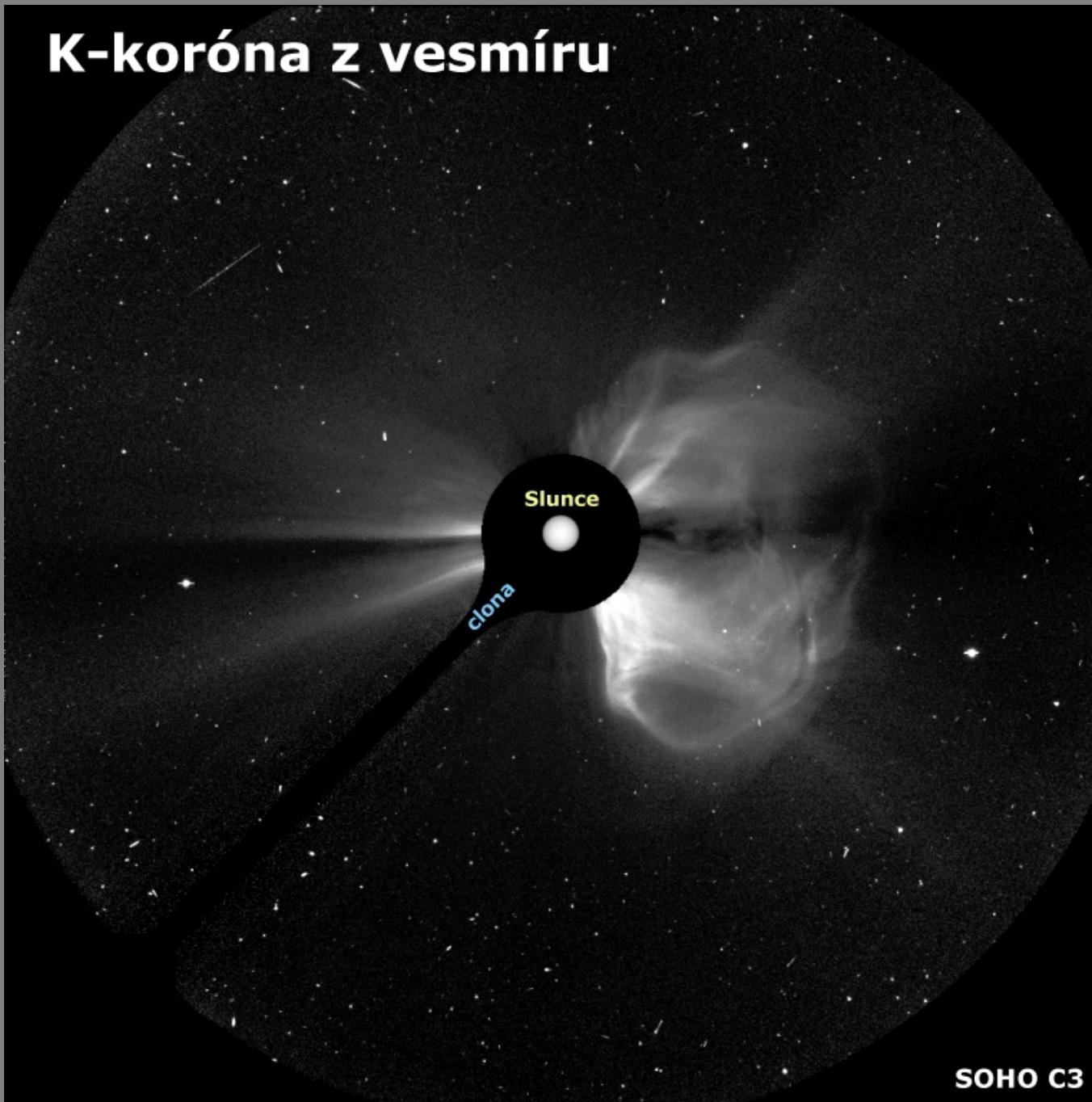


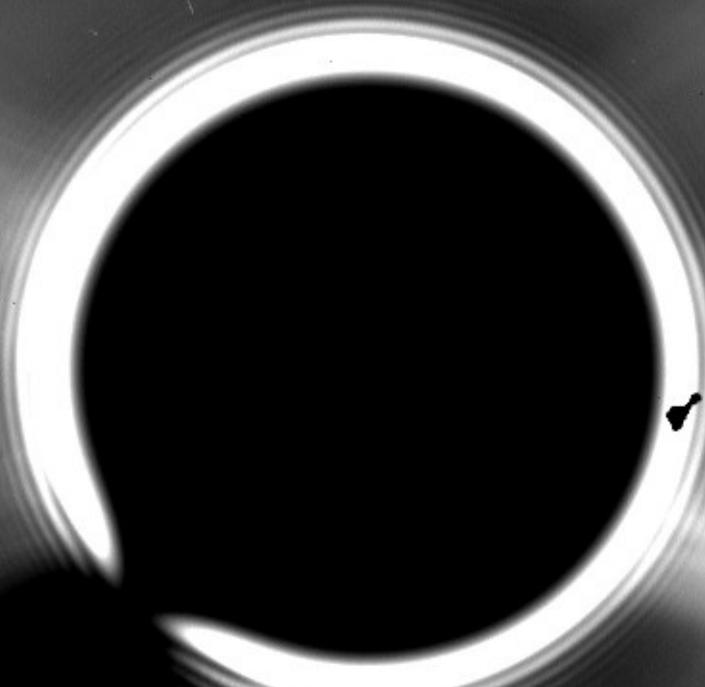
Spektrum E-koróny



Spektrum K-koróny

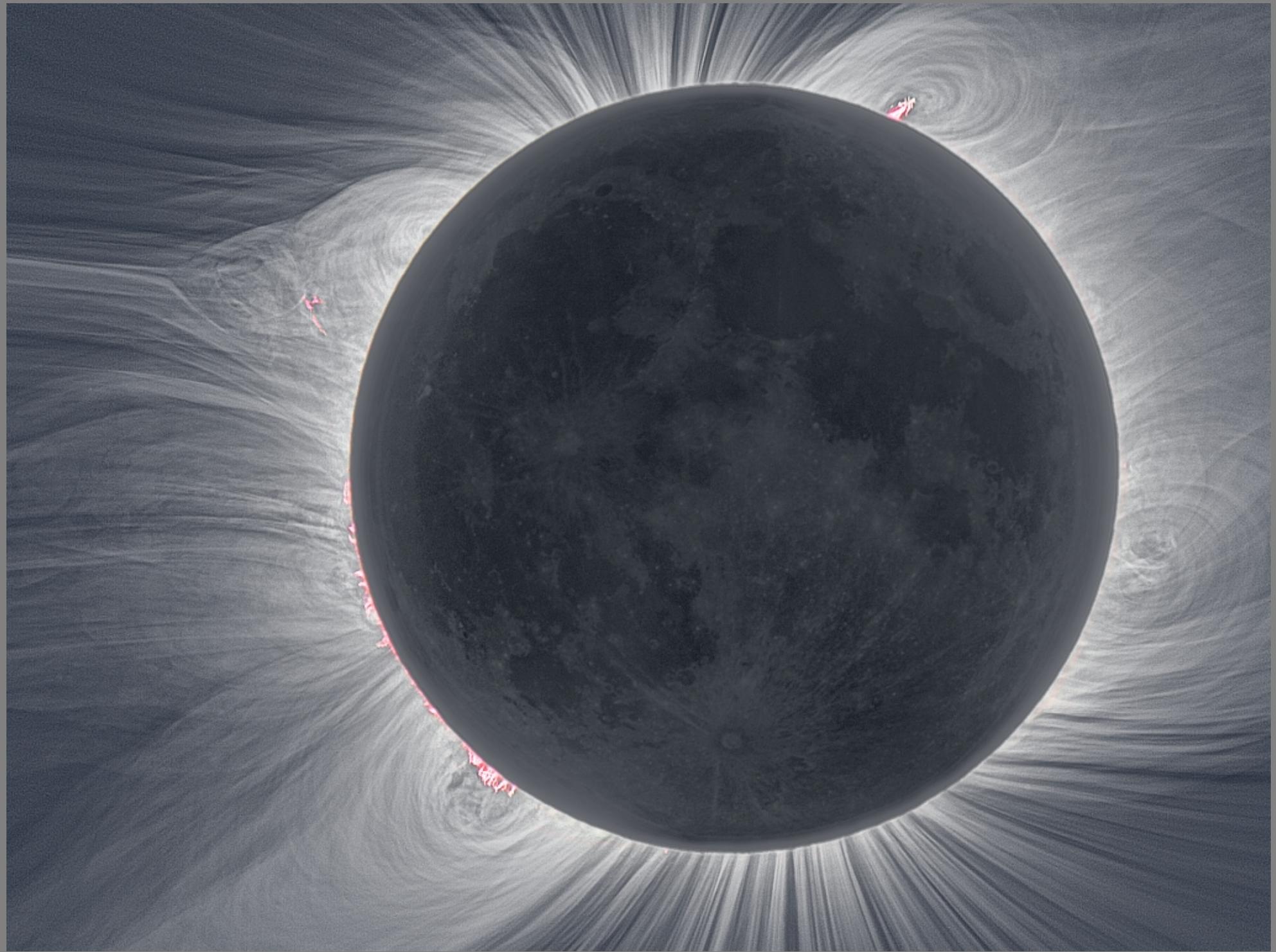
K-koróna z vesmíru

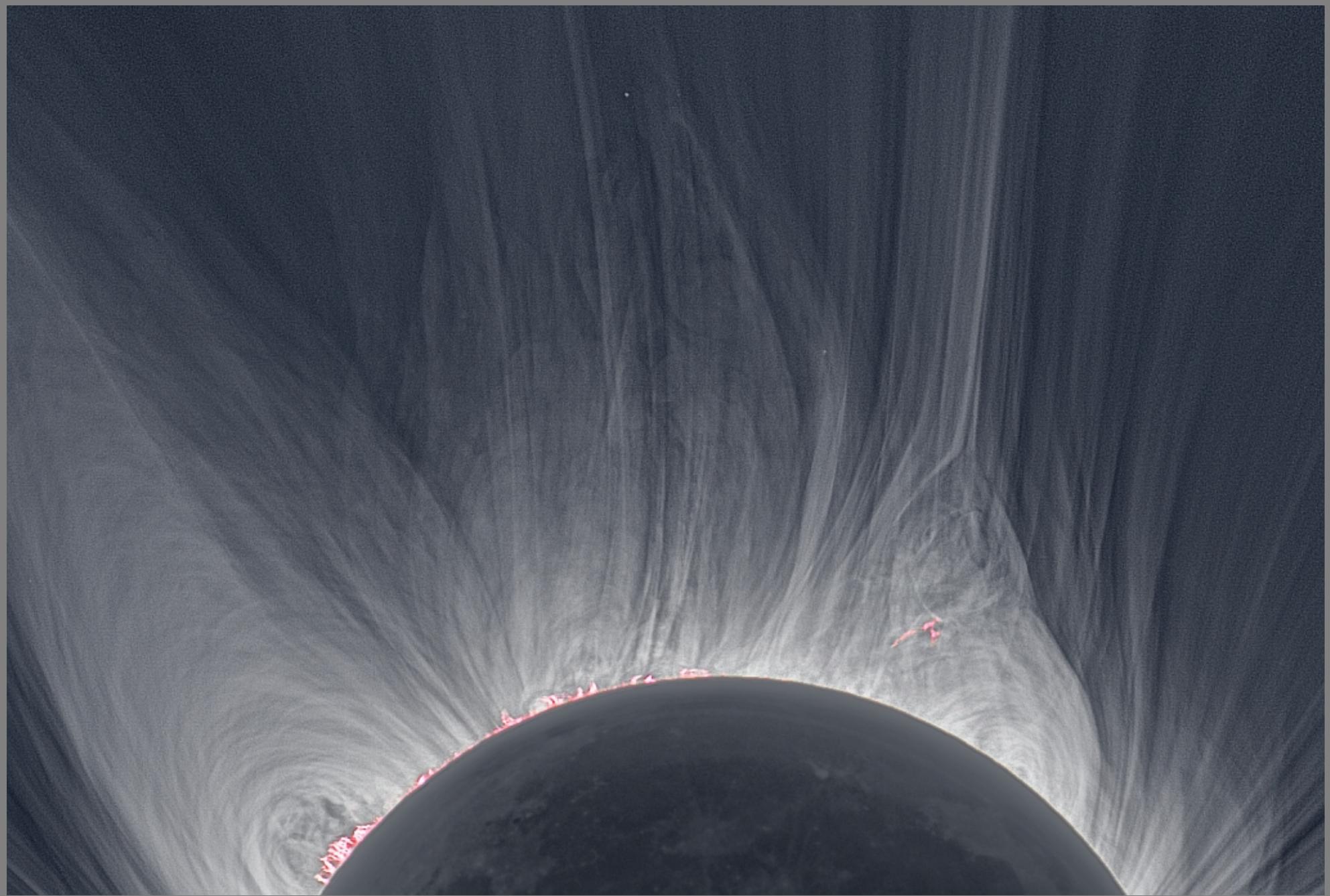


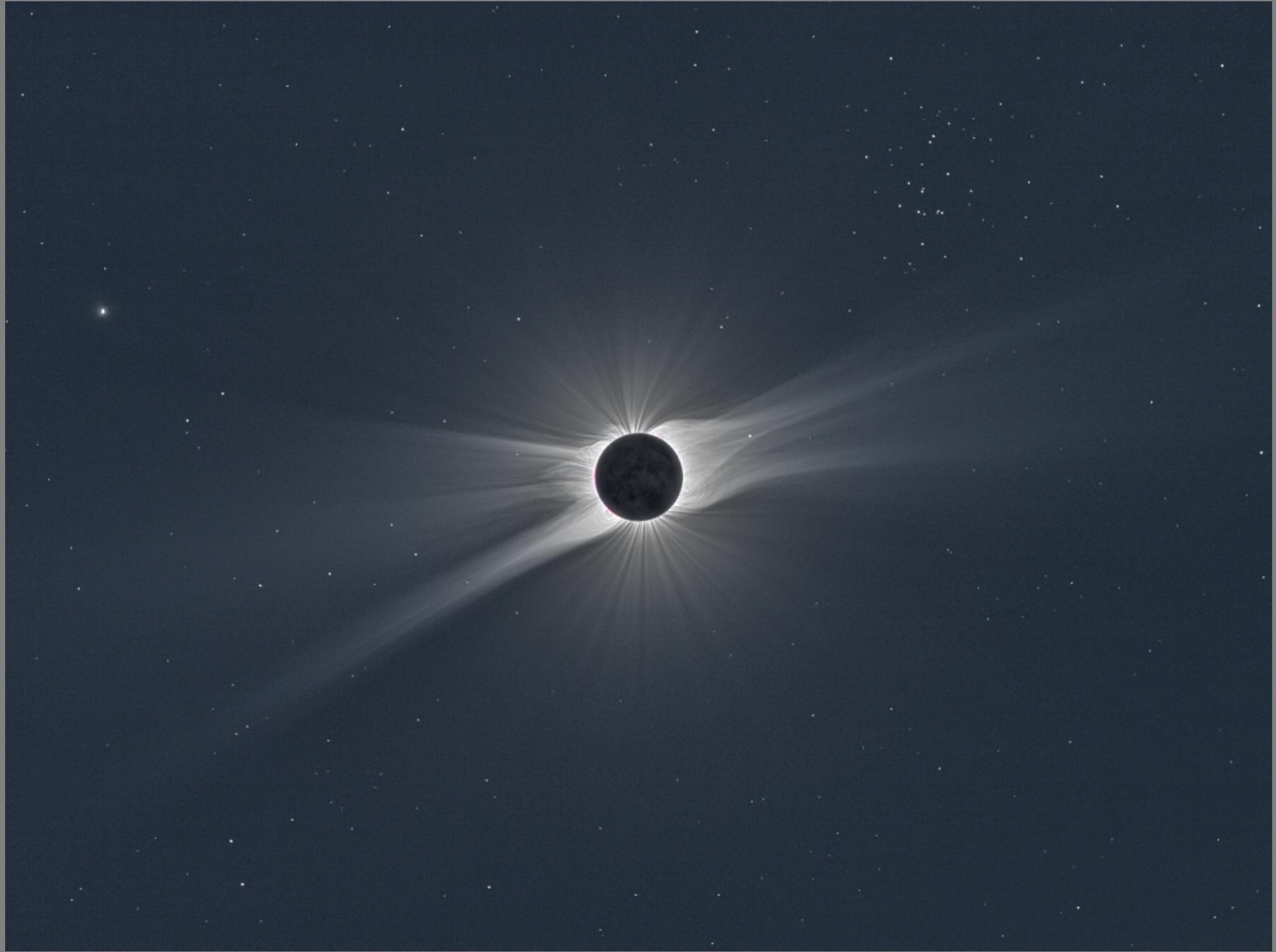




K-koróna během úplného zatmění Slunce



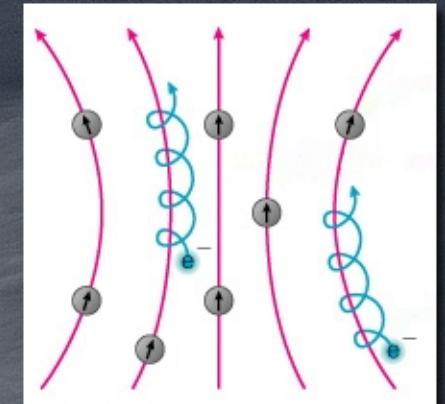
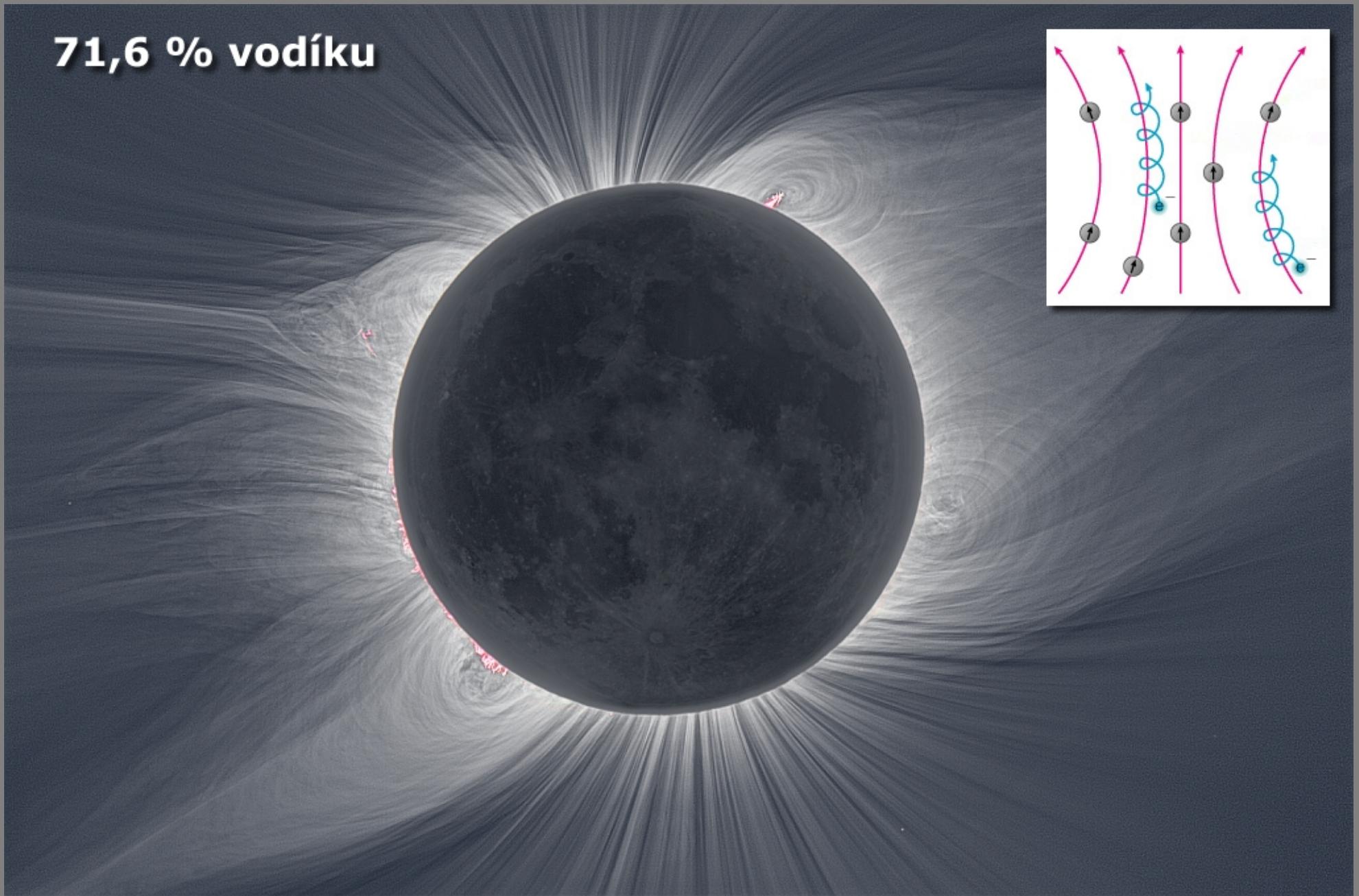






Proč je vidět koróna během úplného zatmění Slunce?

71,6 % vodíku



Účinný průřez (velikost) protonu a elektronu

$$P = k \frac{q^4}{m^2}$$

$$-q_e = q_p = 1.602 \cdot 10^{-19} \text{ C}$$

$$m_e = 9.110 \cdot 10^{-31} \text{ kg}$$

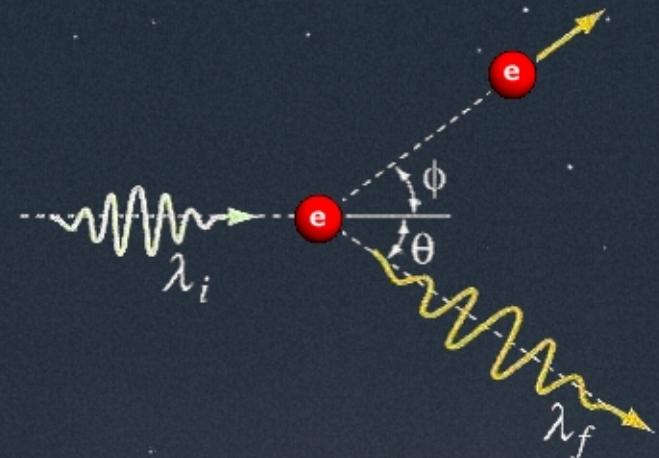
$$m_p = 1\ 836.12 m_e$$

$$P_e/P_p = m_p^2/m_e^2 = 3\ 371\ 336/1$$



Comptonův jev

pružná srážka fotonu s elektronem

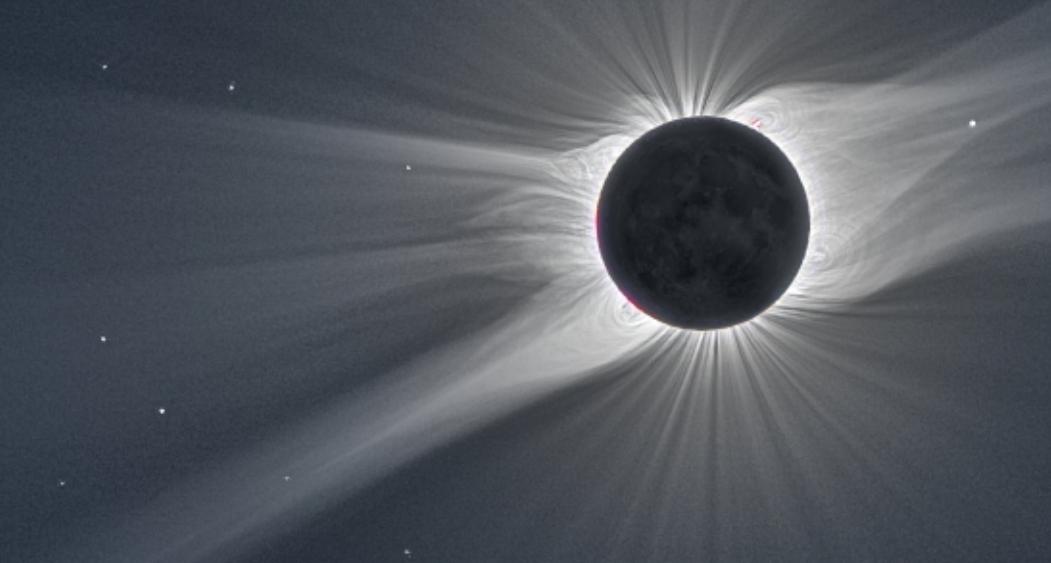


$$\Delta\lambda = \lambda_f - \lambda_i = \frac{h}{m_e c} (1 - \cos \theta)$$

$$\frac{h}{m_e c} = 2.43 \cdot 10^{-3} \text{ nm}$$

$$\Delta\lambda \leq 2.43 \cdot 10^{-3} \text{ nm}$$

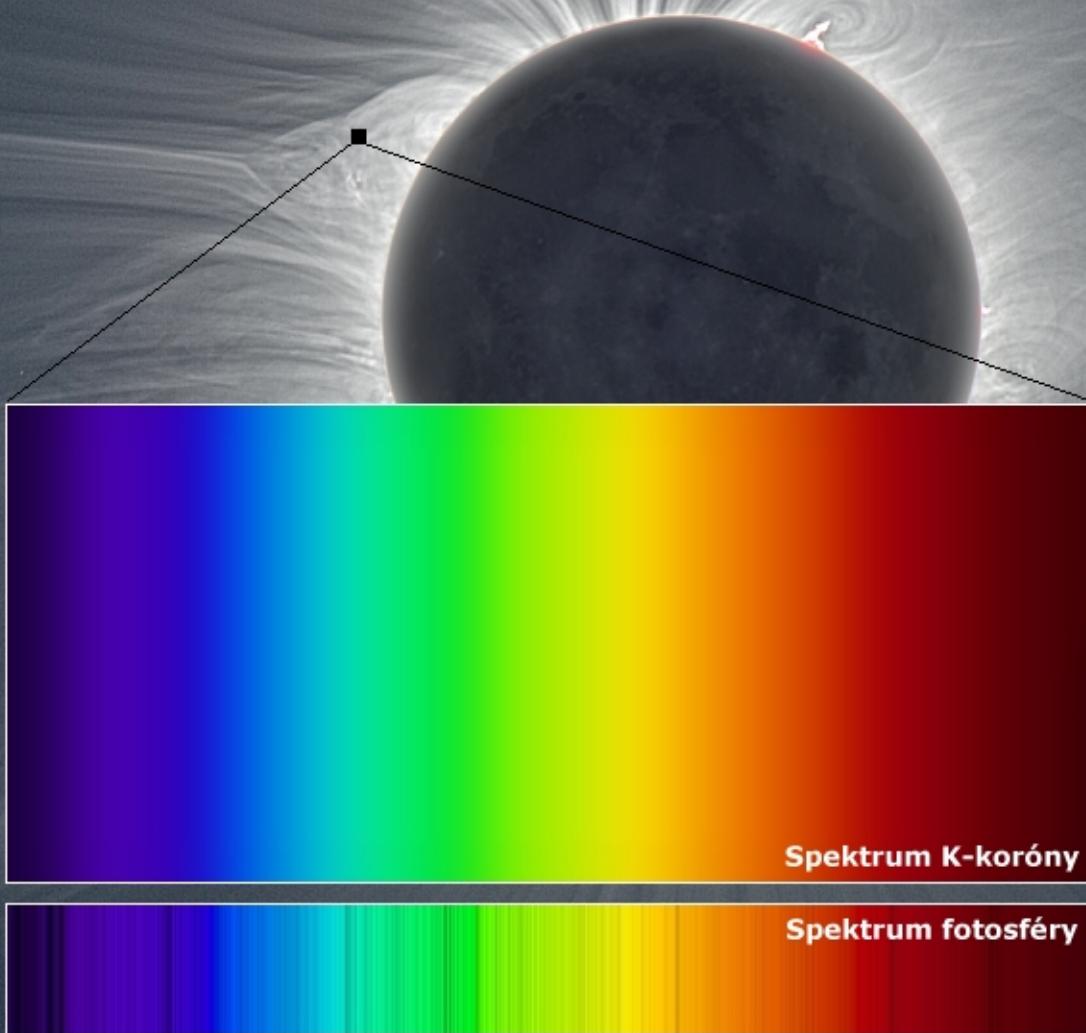
$$\lambda_v \in \langle 400, 700 \rangle \text{ nm}$$



$$\Delta\lambda = \frac{v_e}{c} \lambda$$

Dopplerův jev

$$v_e = 600 \text{ km/s} \quad \wedge \quad \lambda = 500 \text{ nm} \quad \Rightarrow \quad \Delta\lambda = 1 \text{ nm}$$



$$S_F(\lambda)$$

Spektrum fotosféry



$$S_K(\lambda)$$

Spektrum K-koróny



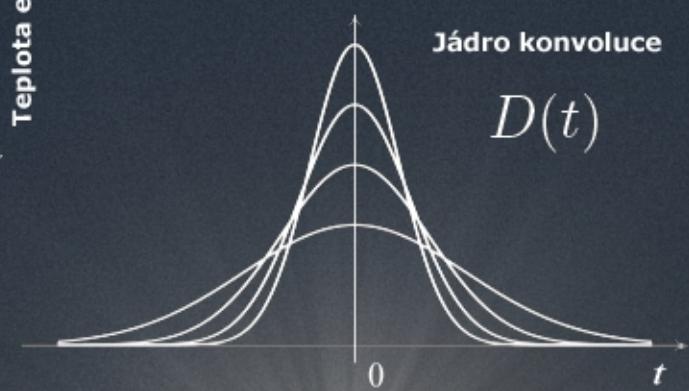
Teplota elektronů

Maxwellovo - Boltzmannovo
rozložení

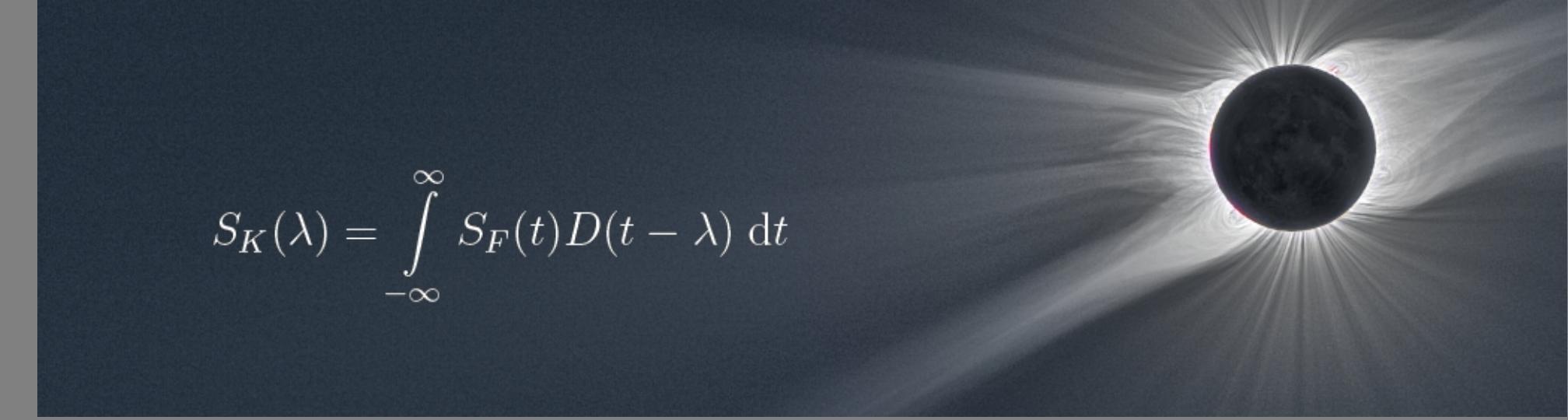


Jádro konvoluce

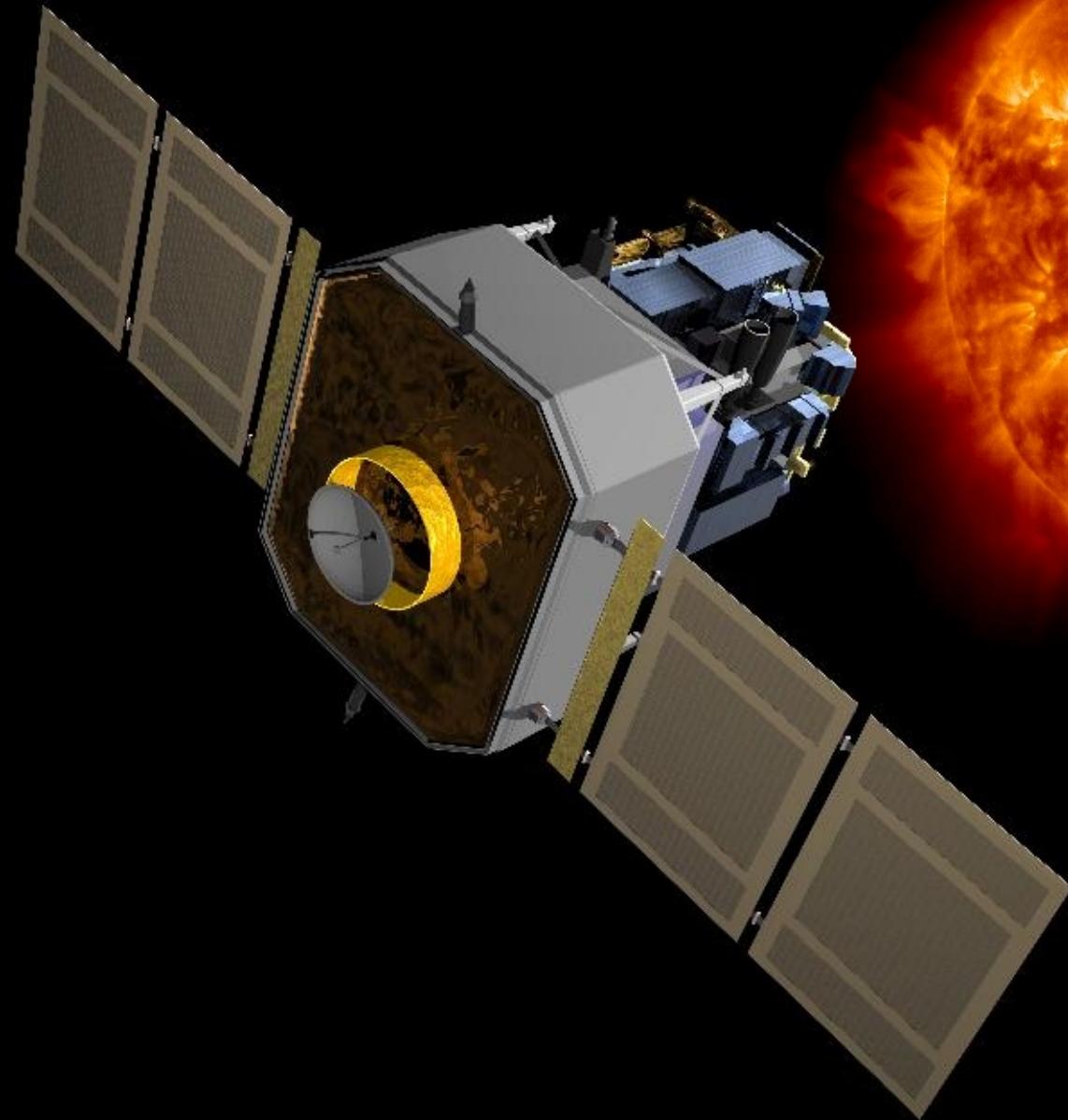
$$D(t)$$



$$S_K(\lambda) = \int_{-\infty}^{\infty} S_F(t) D(t - \lambda) dt$$

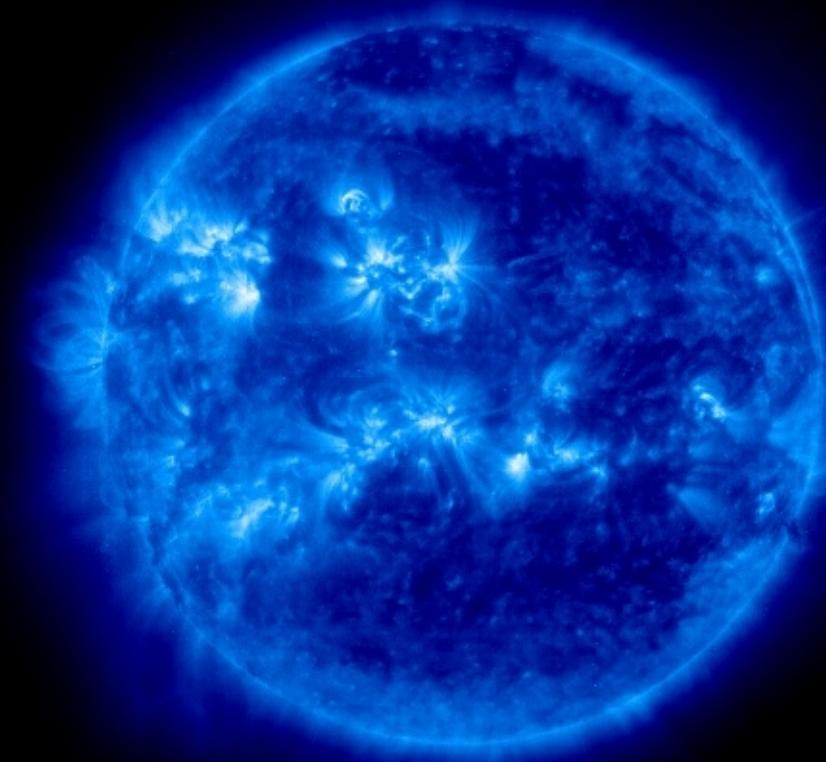


E-koróna z vesmíru



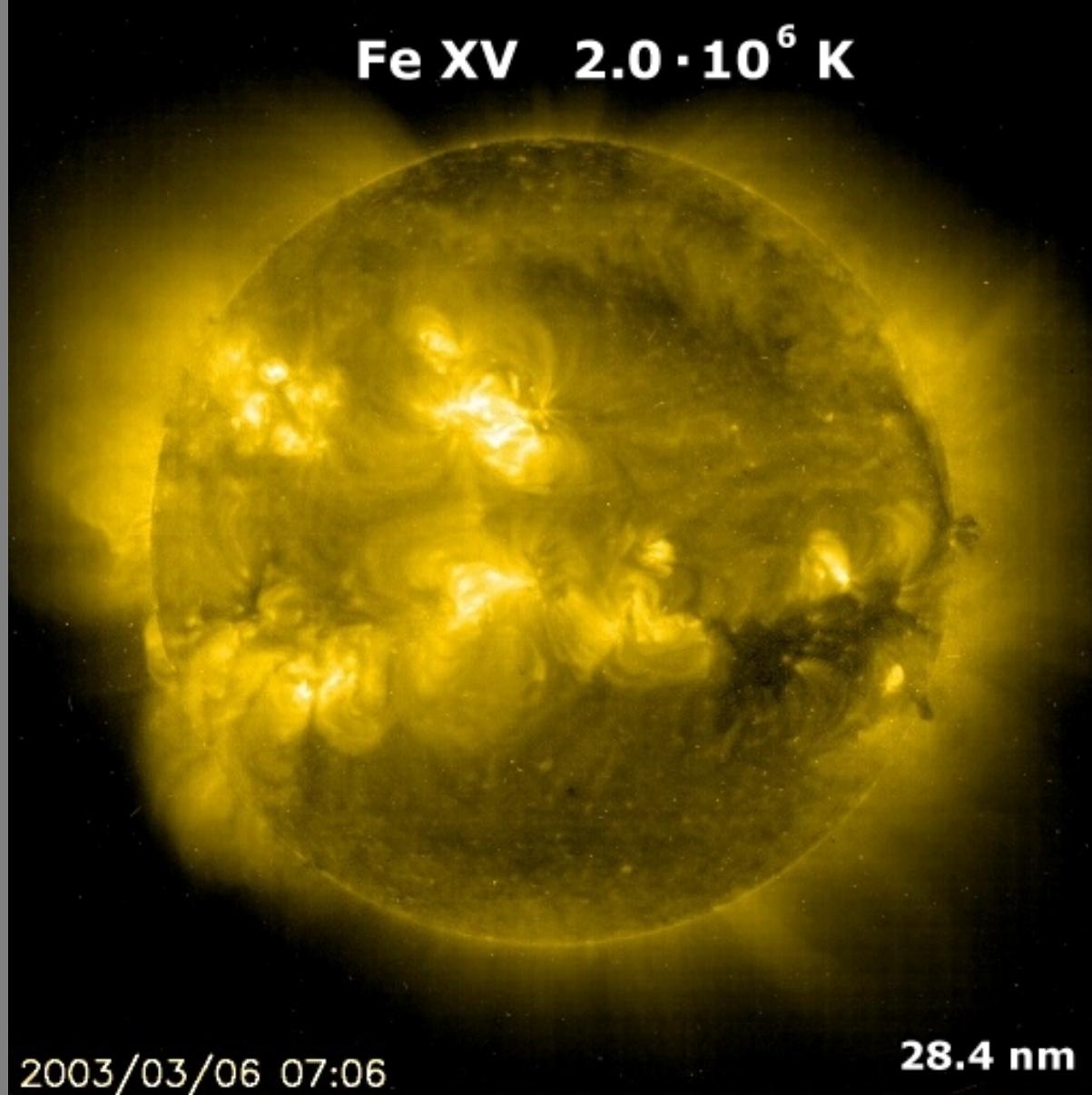
SOHO

iont	vlnová délka	střední doba života excitovaného stavu
Fe IX	17,1 nm	$5 \cdot 10^{-12}$ s



SOHO EIT

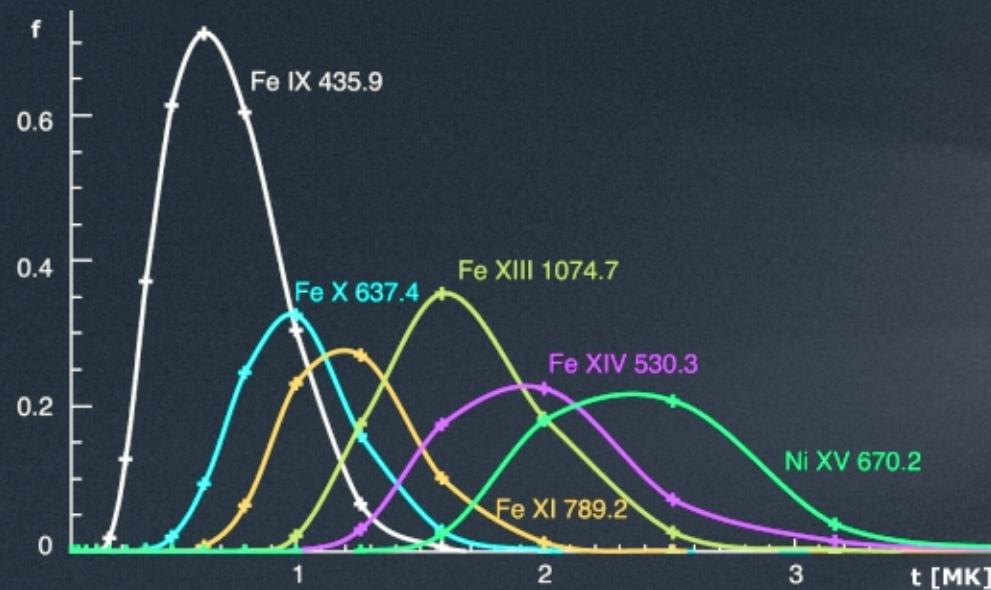
Fe XV $2.0 \cdot 10^6$ K



2003/03/06 07:06

28.4 nm

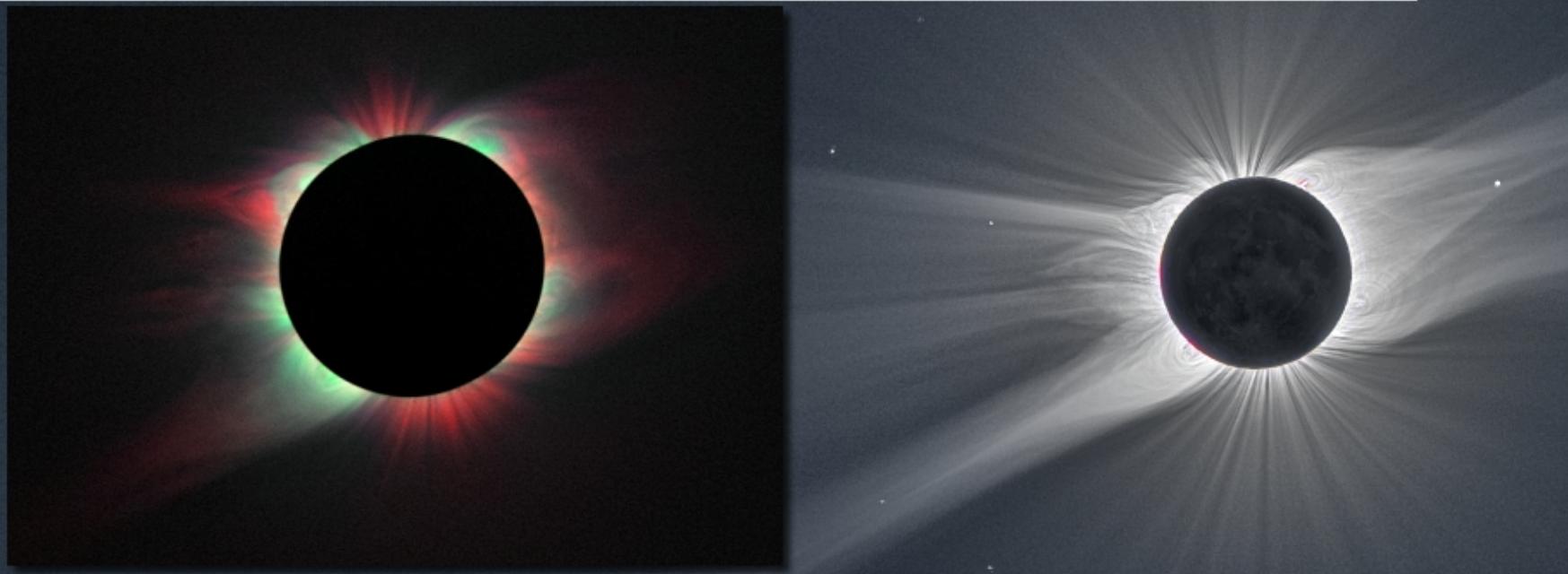
iont	vlnová délka	střední doba života excitovaného stavu
Fe IX	435,9 nm	$6,9 \cdot 10^{-3}$ s
Fe X	637,4 nm	$1,44 \cdot 10^{-2}$ s
Fe XI	789,2 nm	$2,23 \cdot 10^{-2}$ s
Fe XIII	1074,7 nm	$7,0 \cdot 10^{-2}$ s
Fe XIV	530,3 nm	$1,7 \cdot 10^{-2}$ s
Ni XV	670,2 nm	$1,8 \cdot 10^{-2}$ s

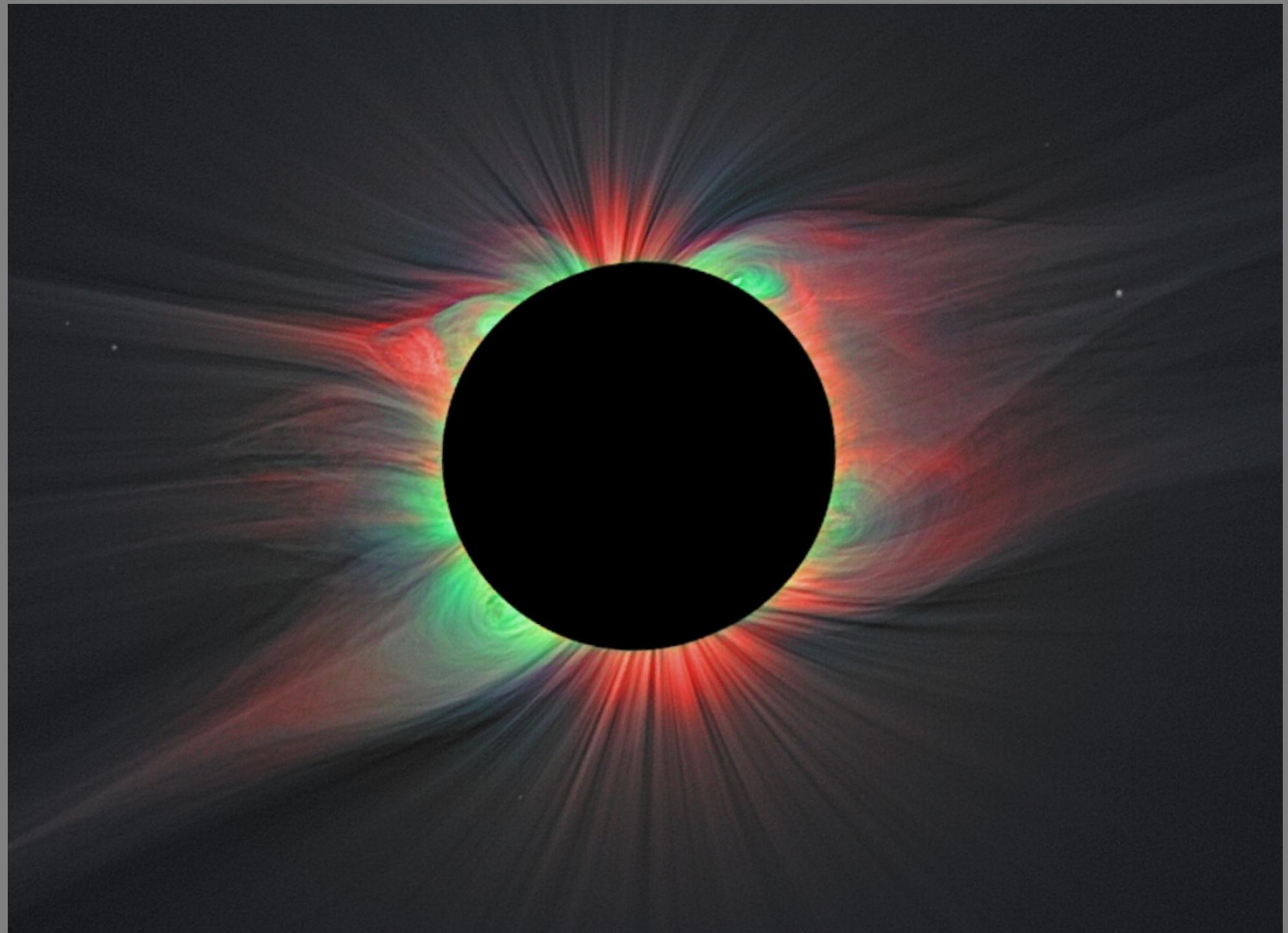


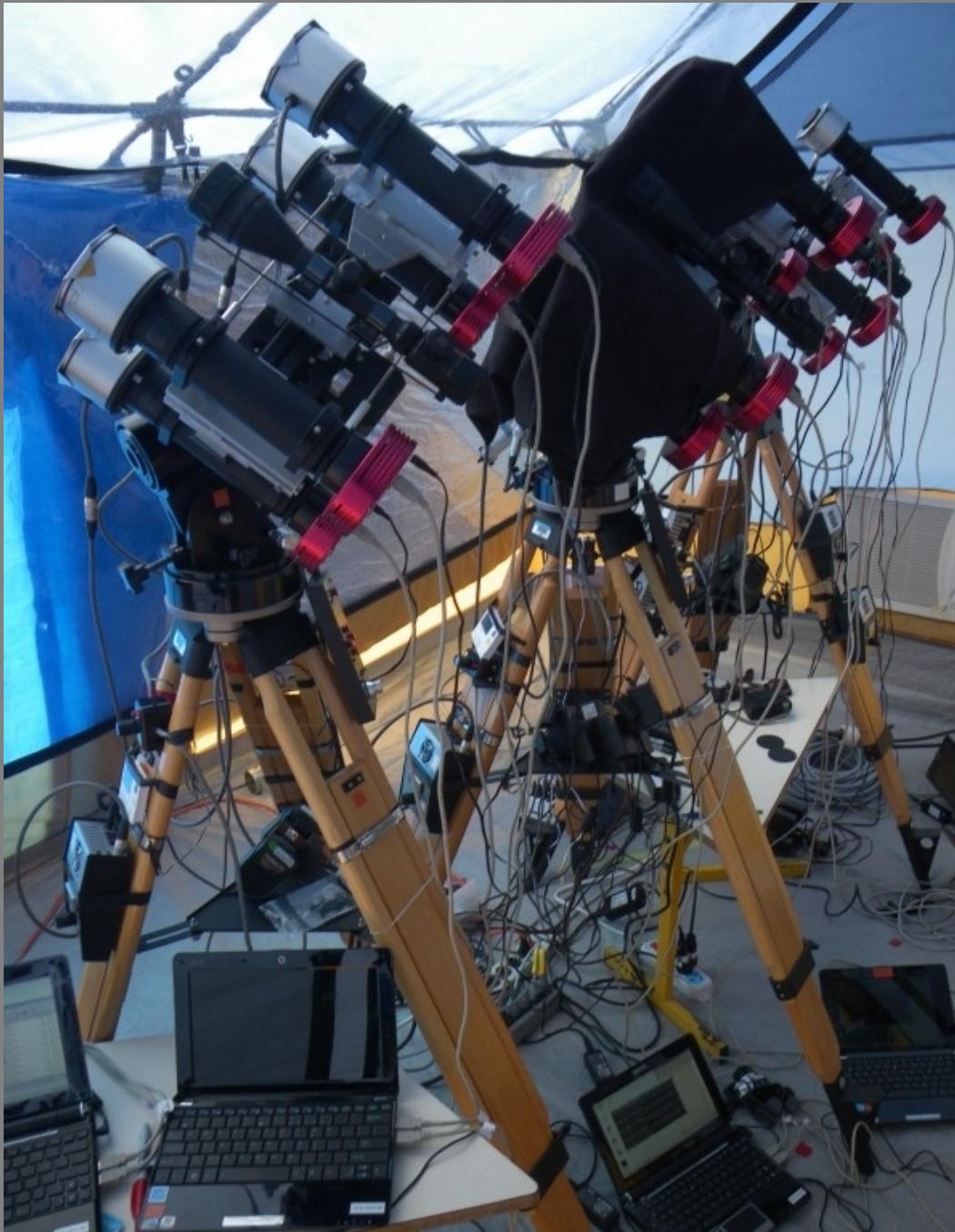
iont	vlnová délka	střední doba života excitovaného stavu
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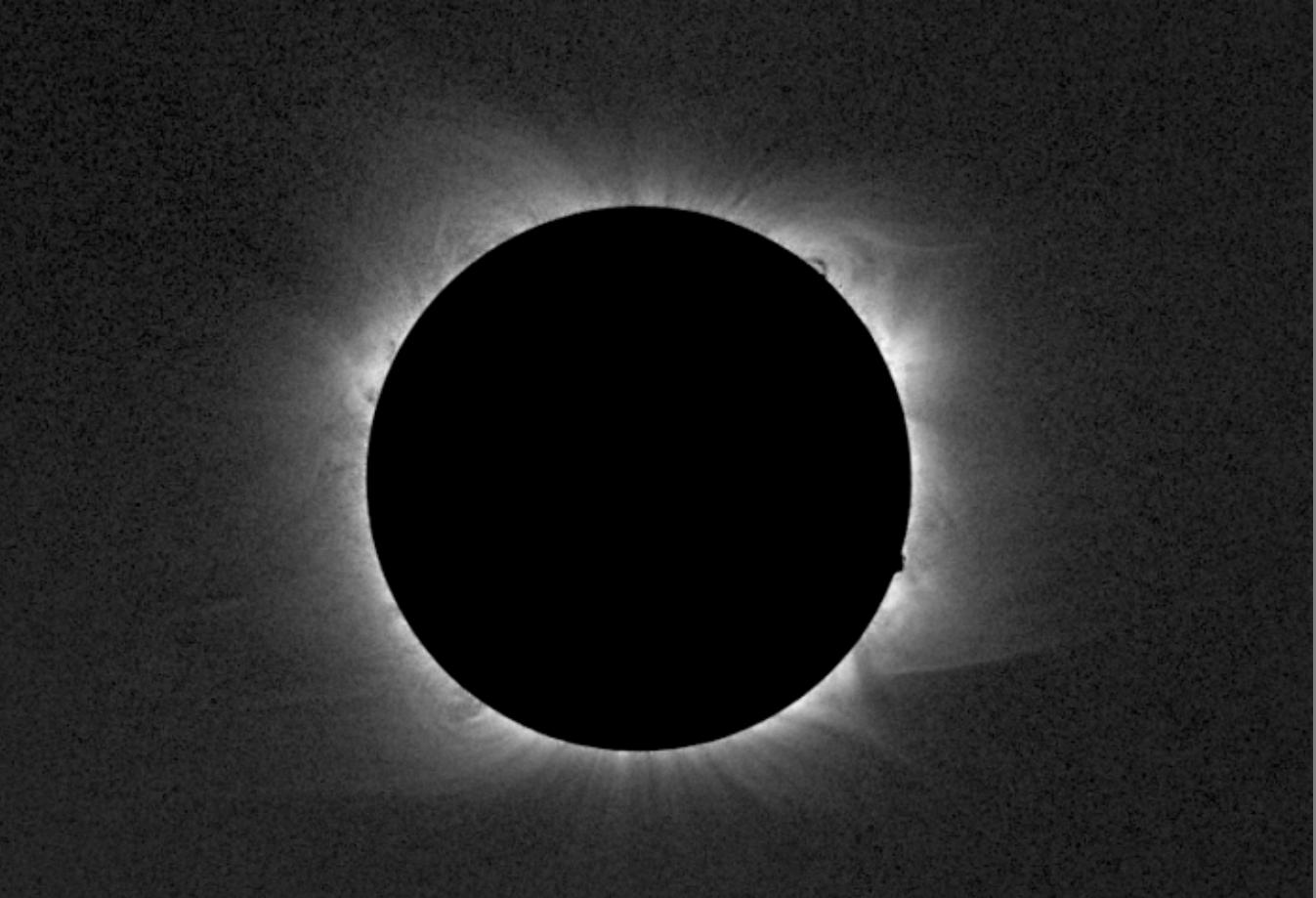
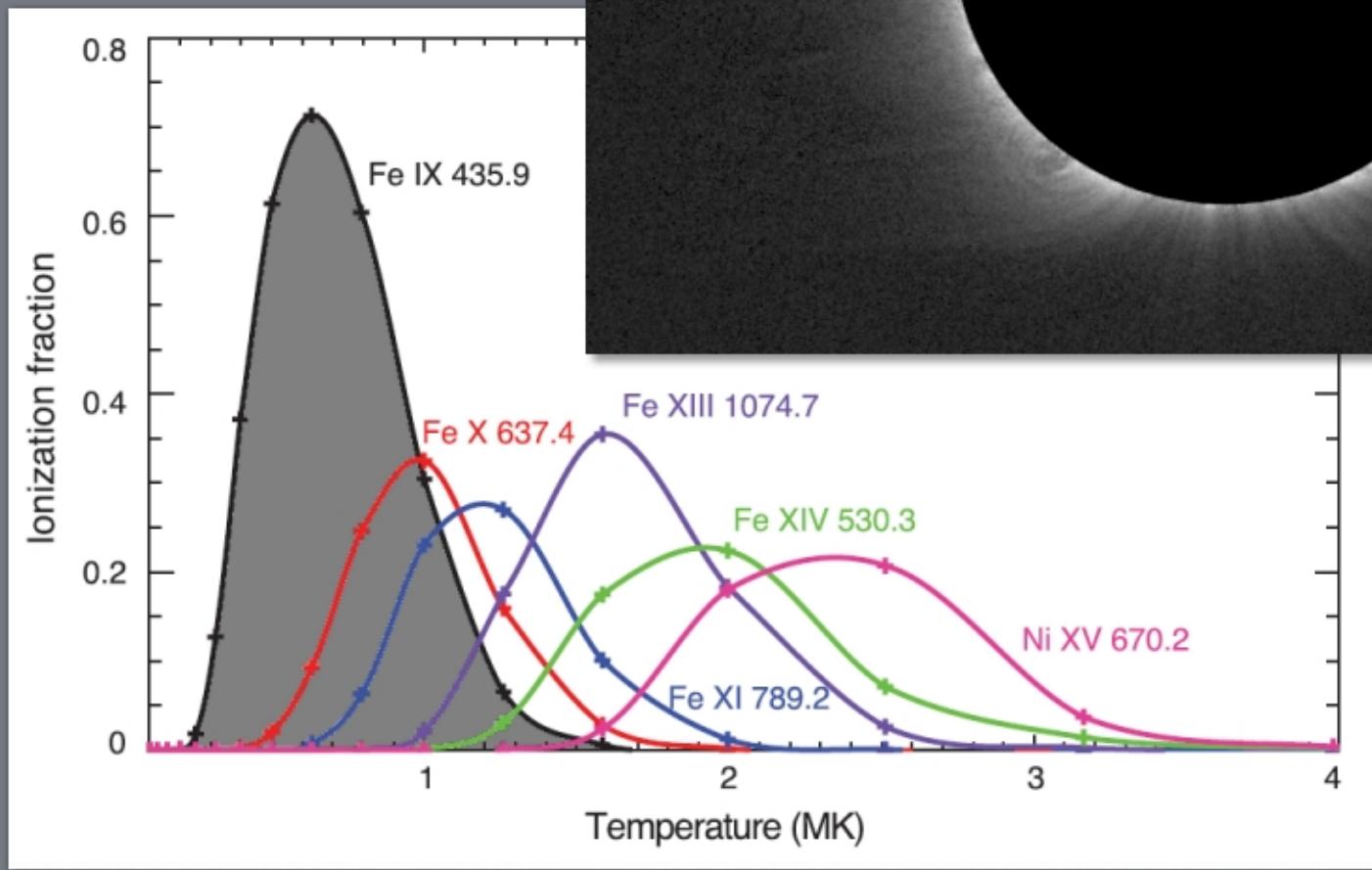


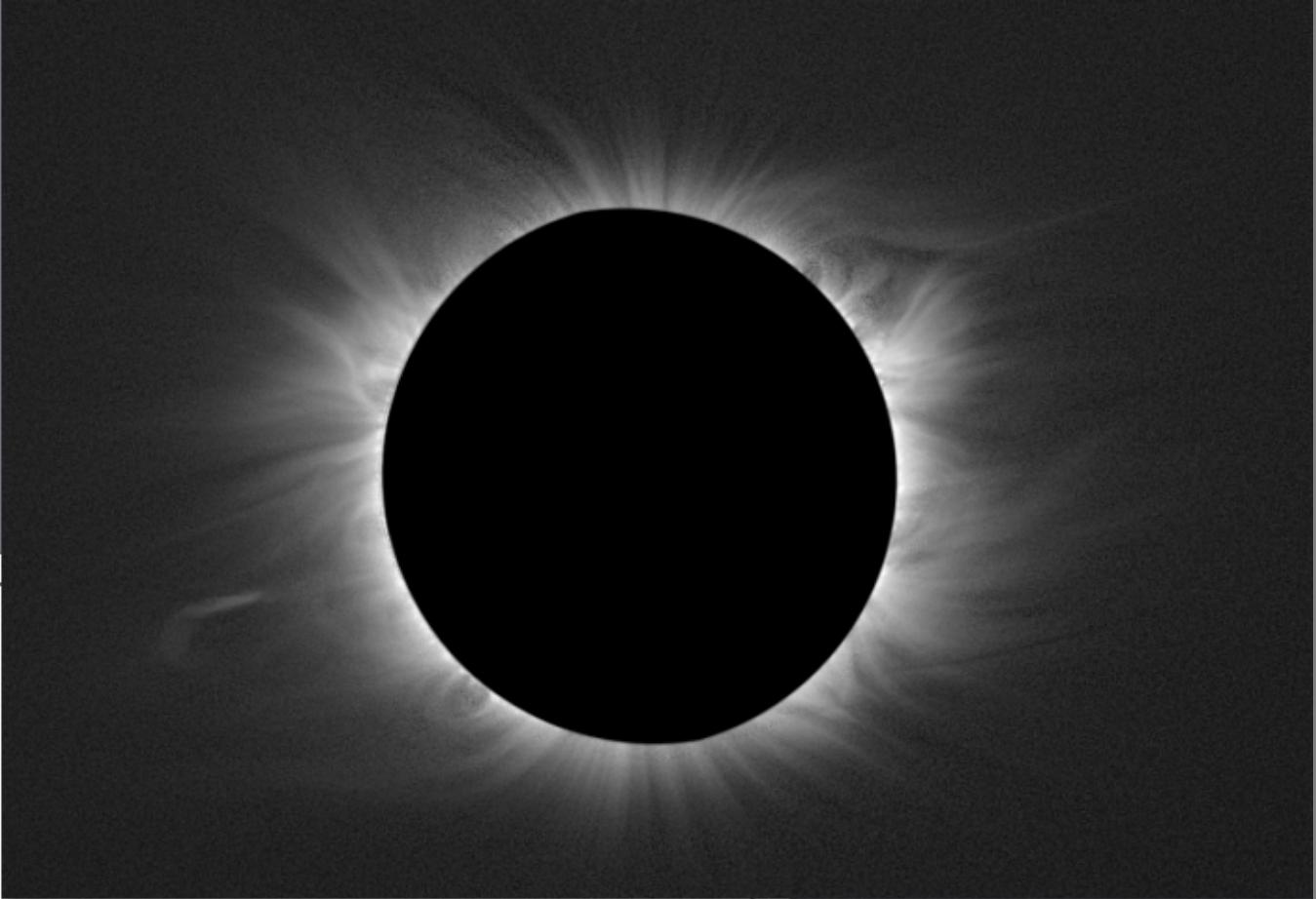
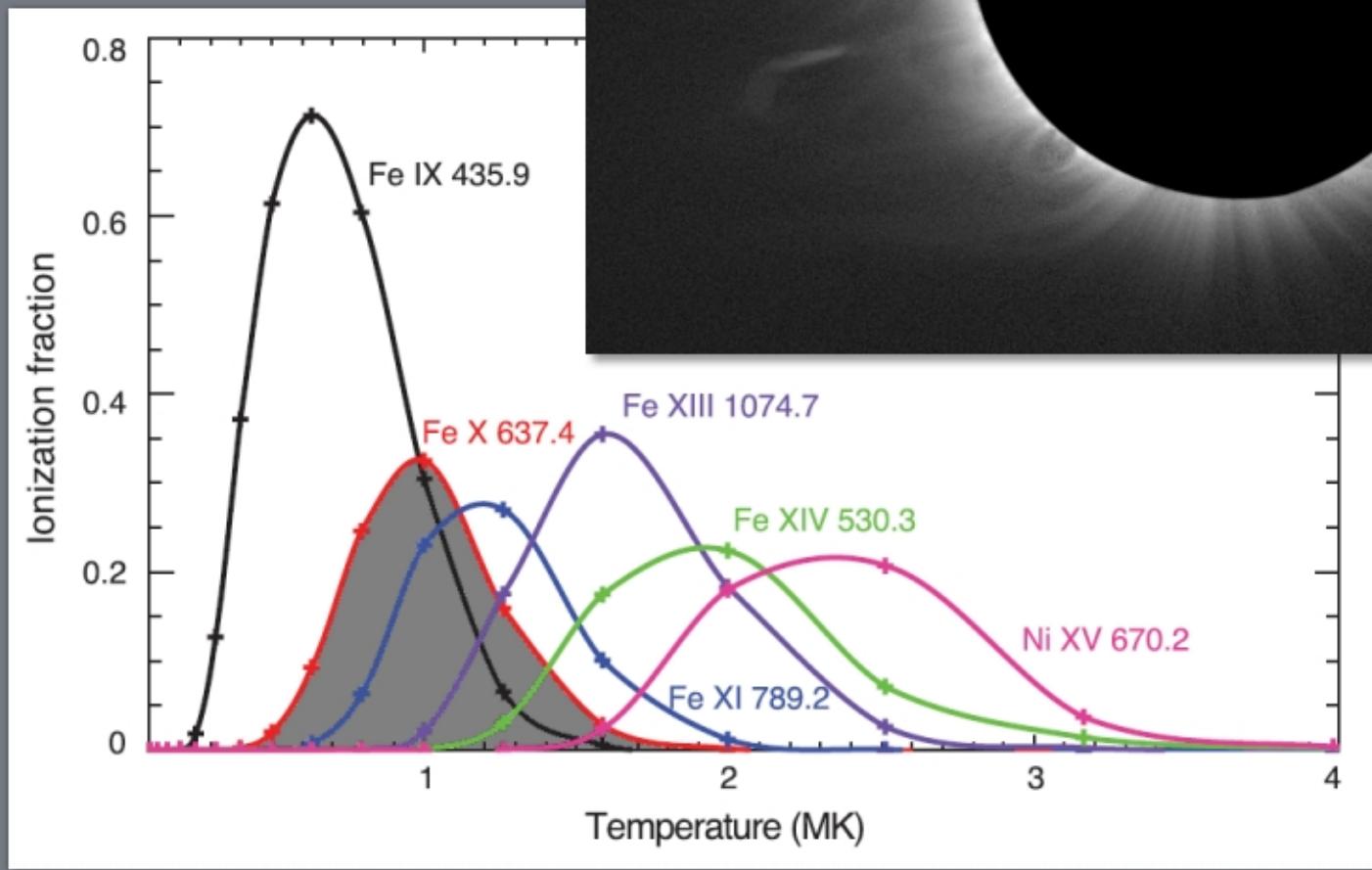
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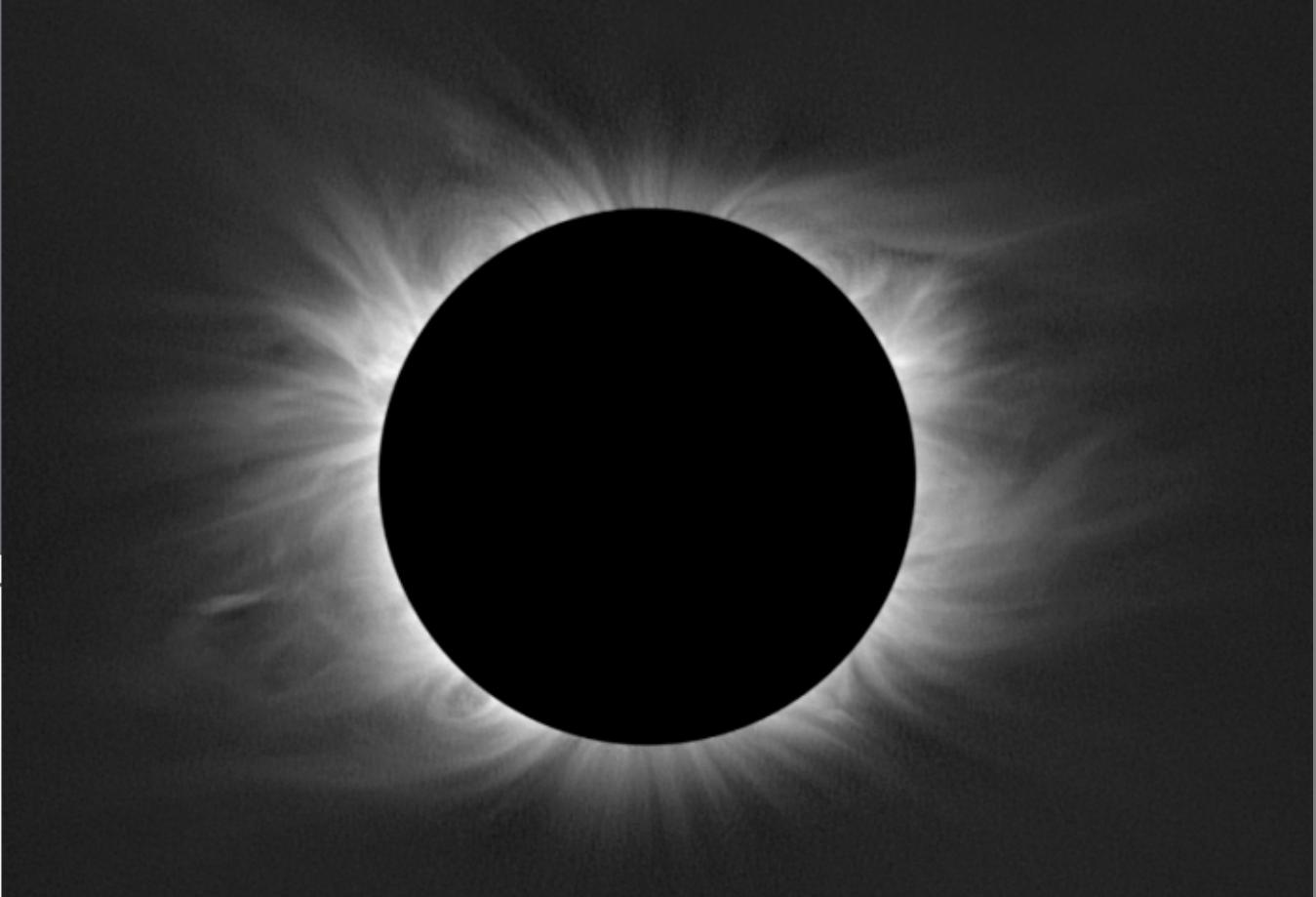
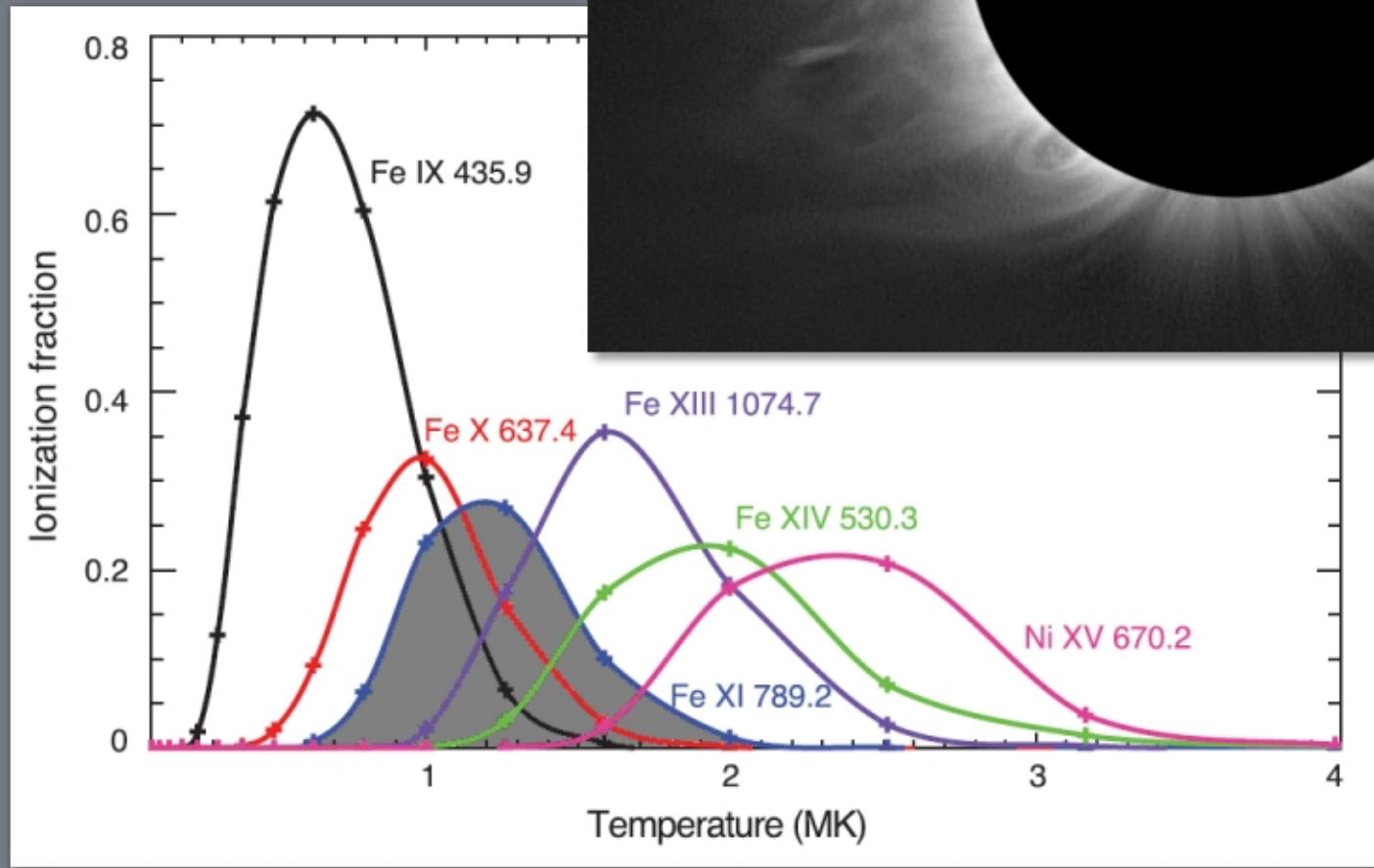


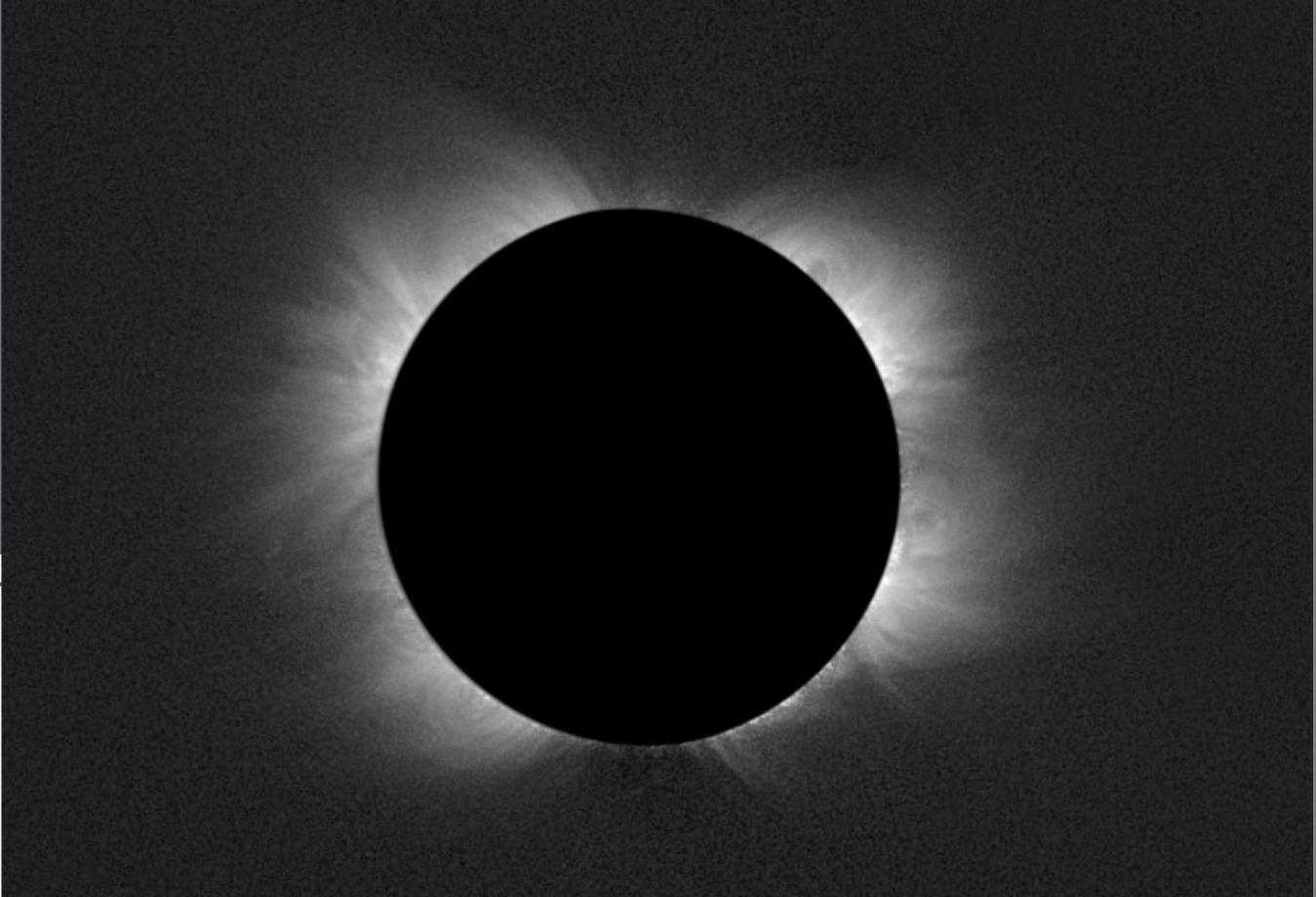
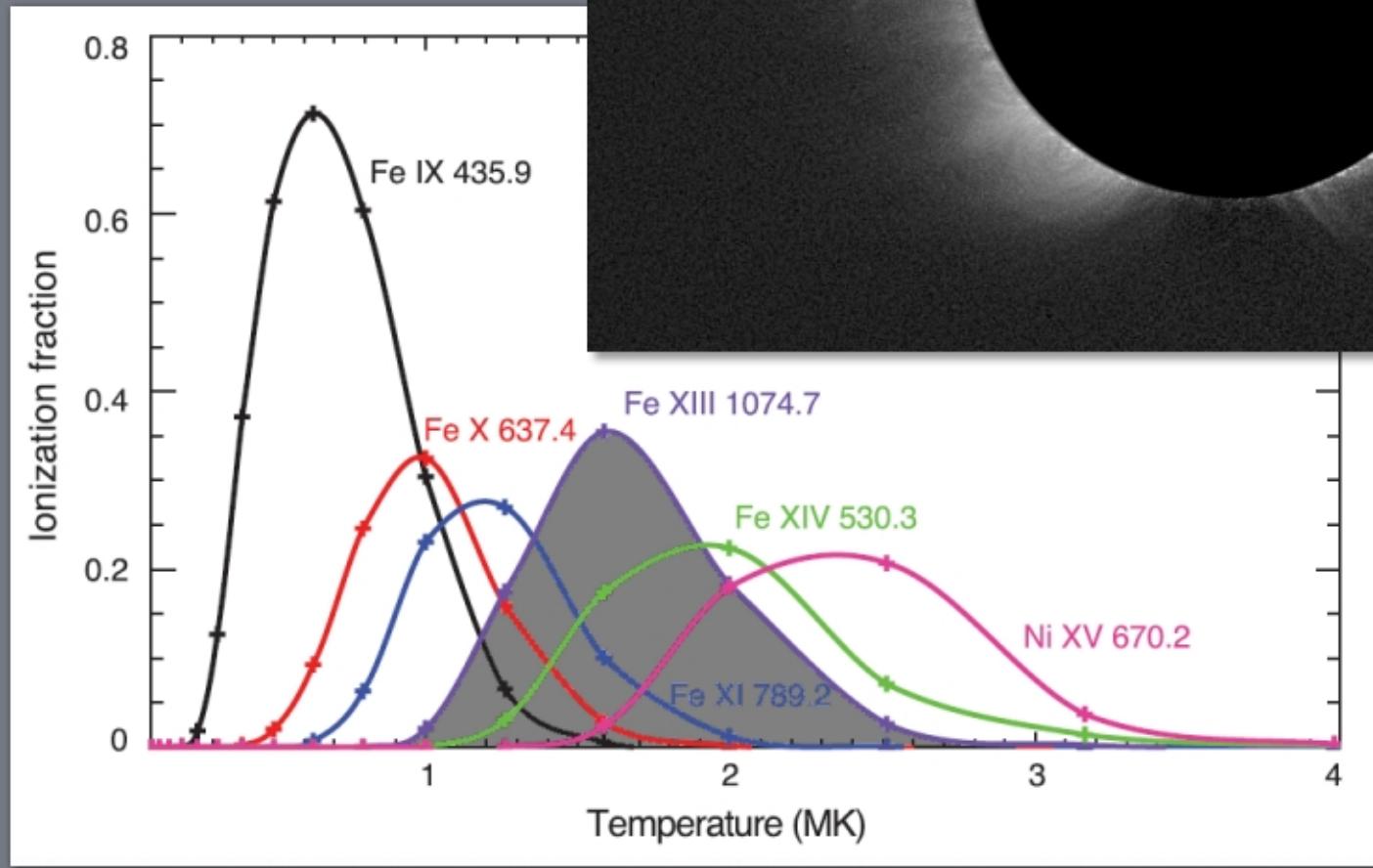


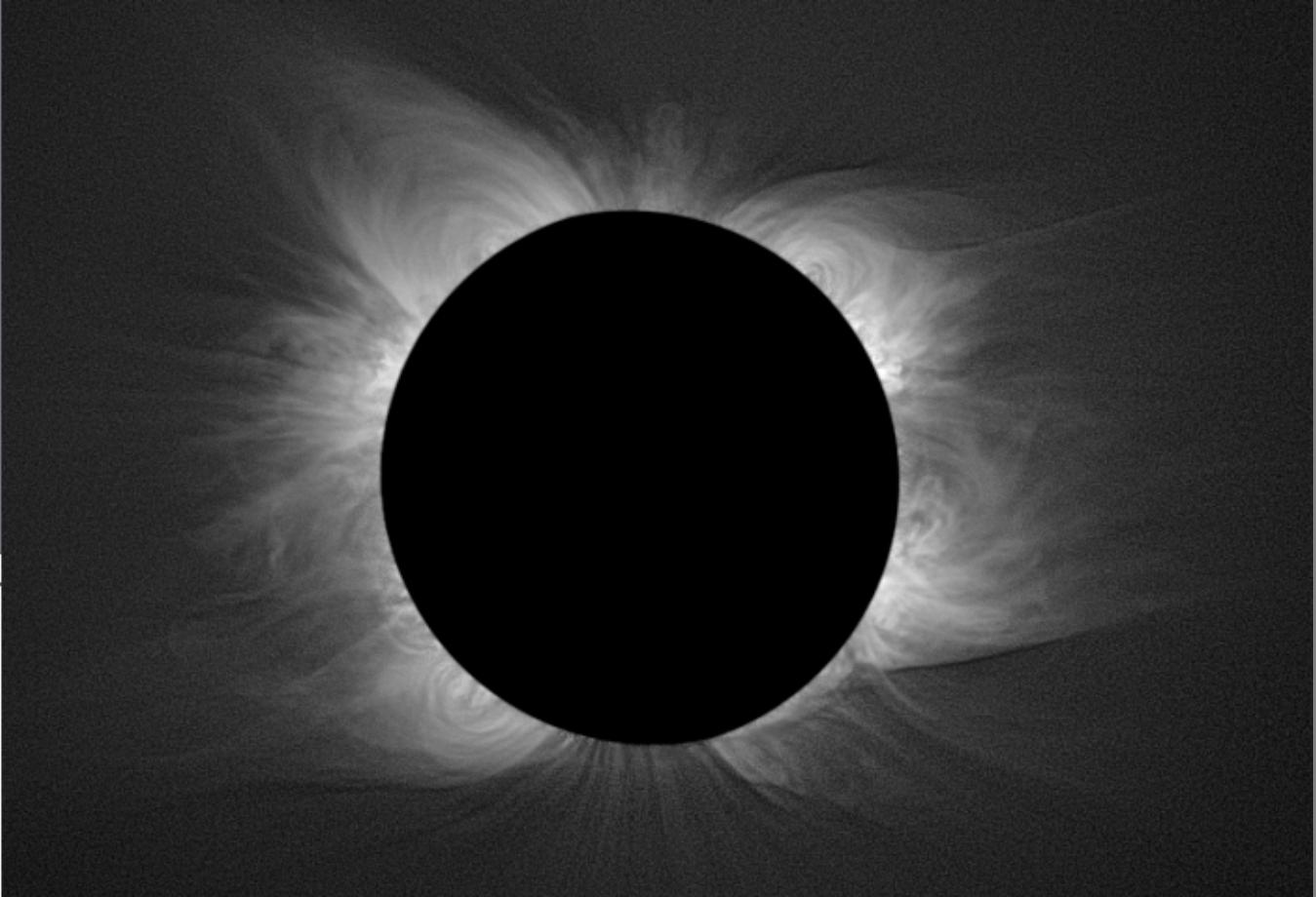
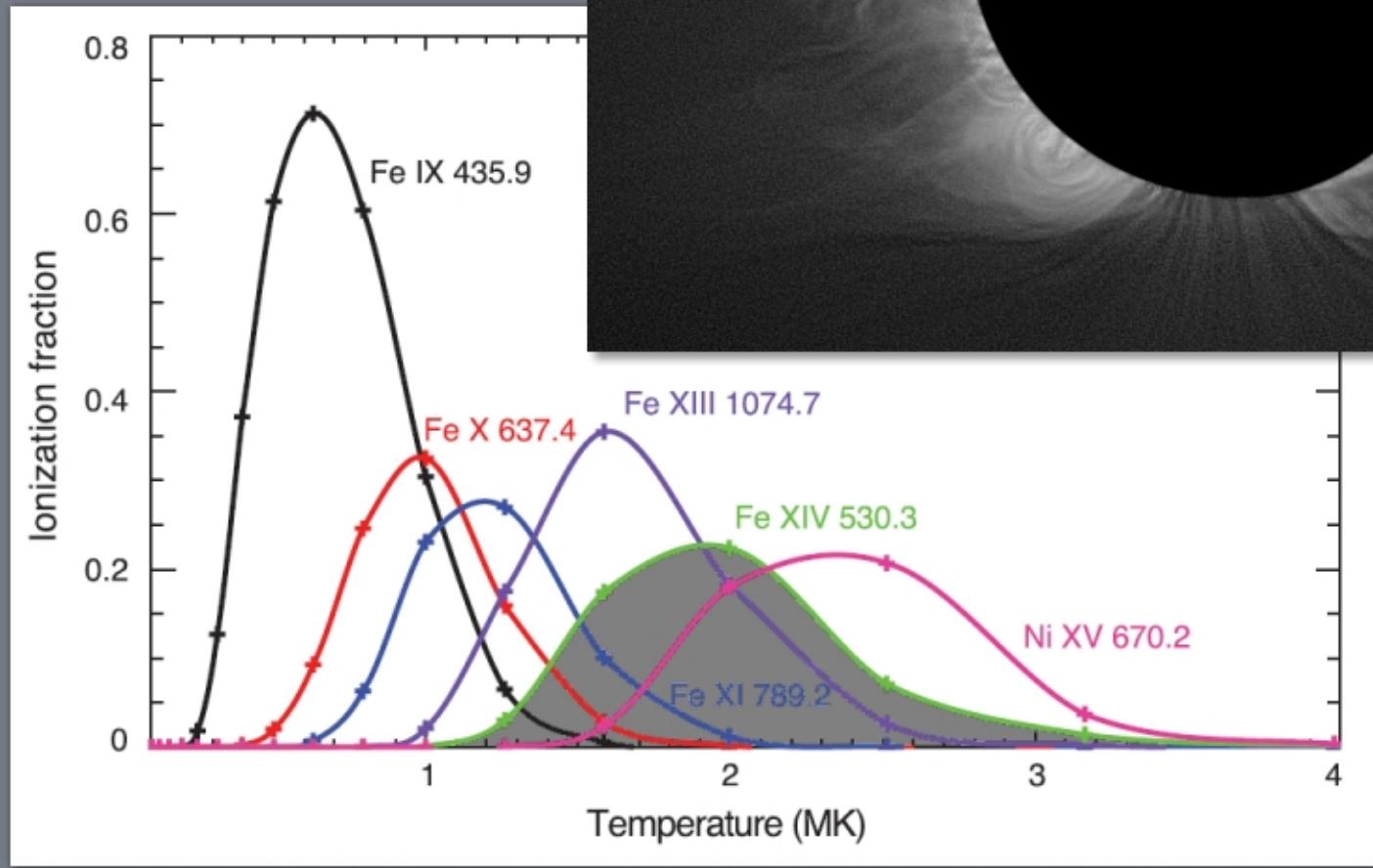












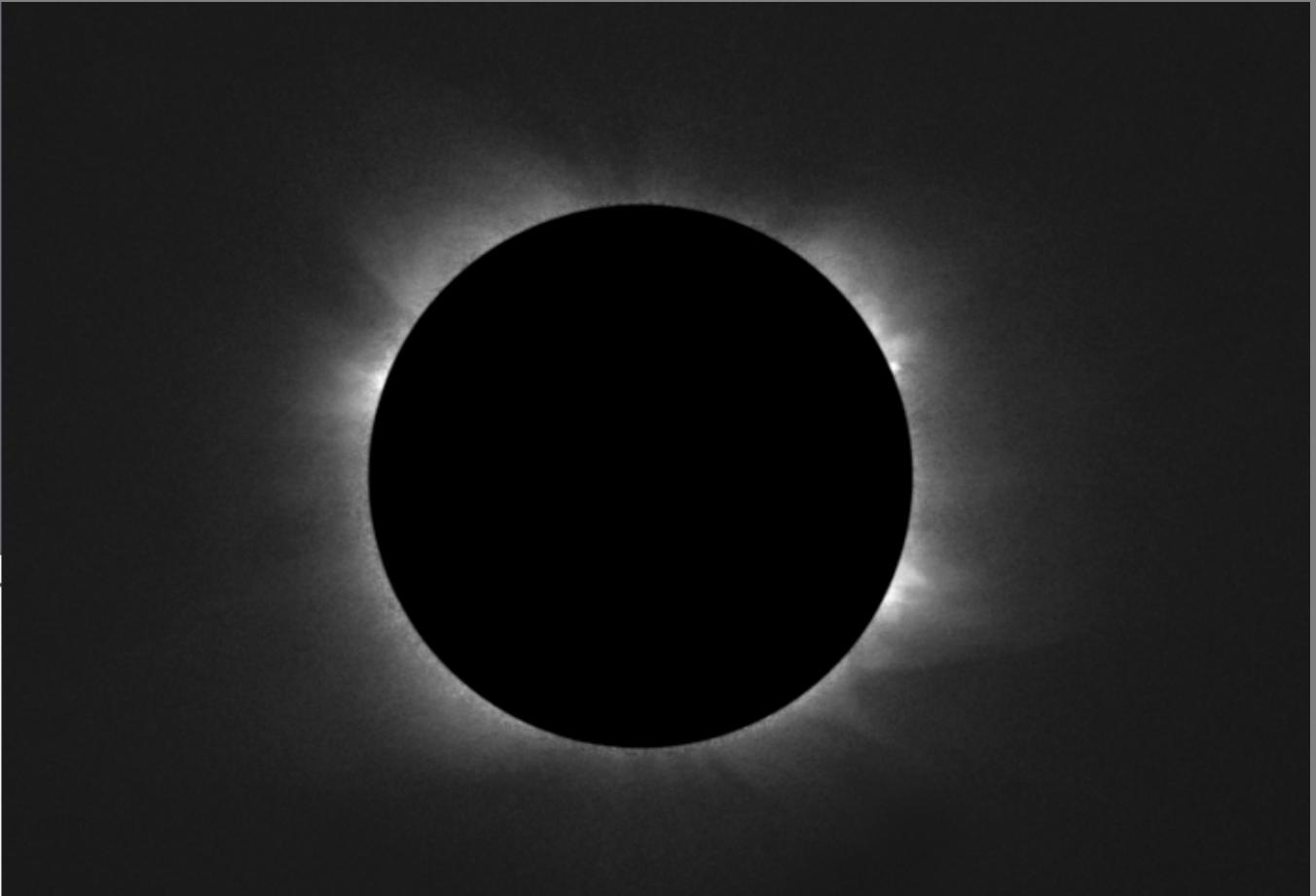
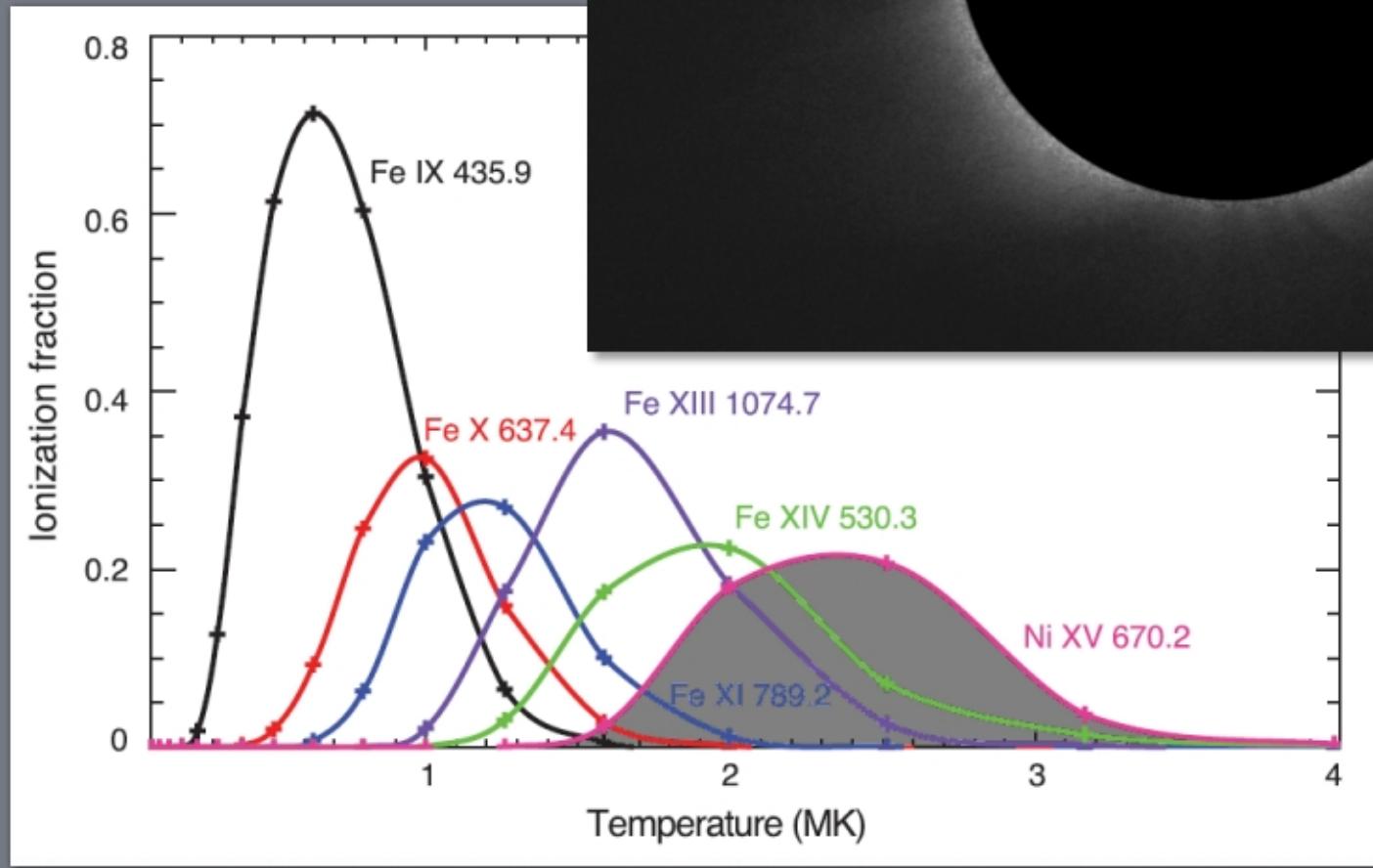
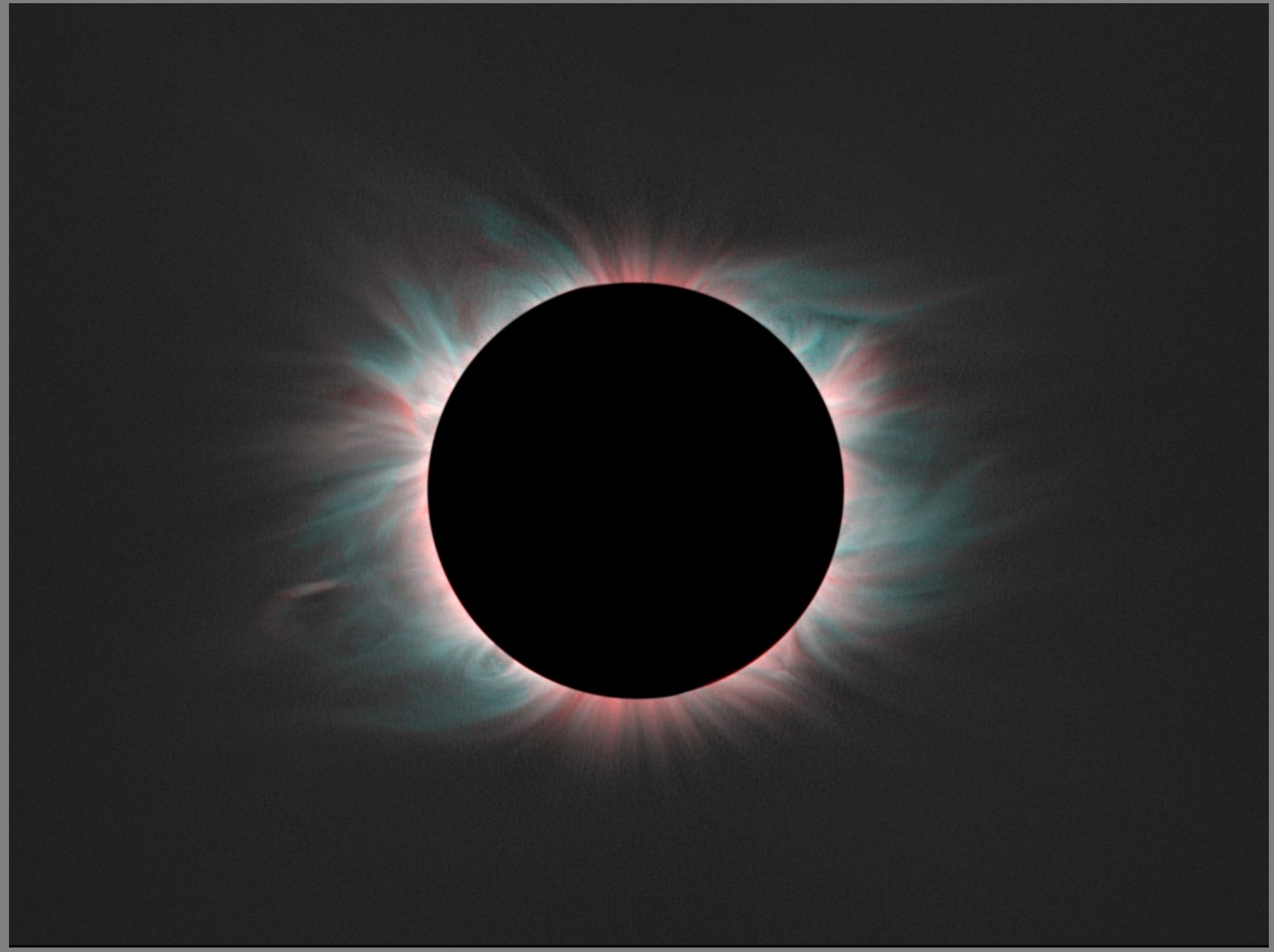
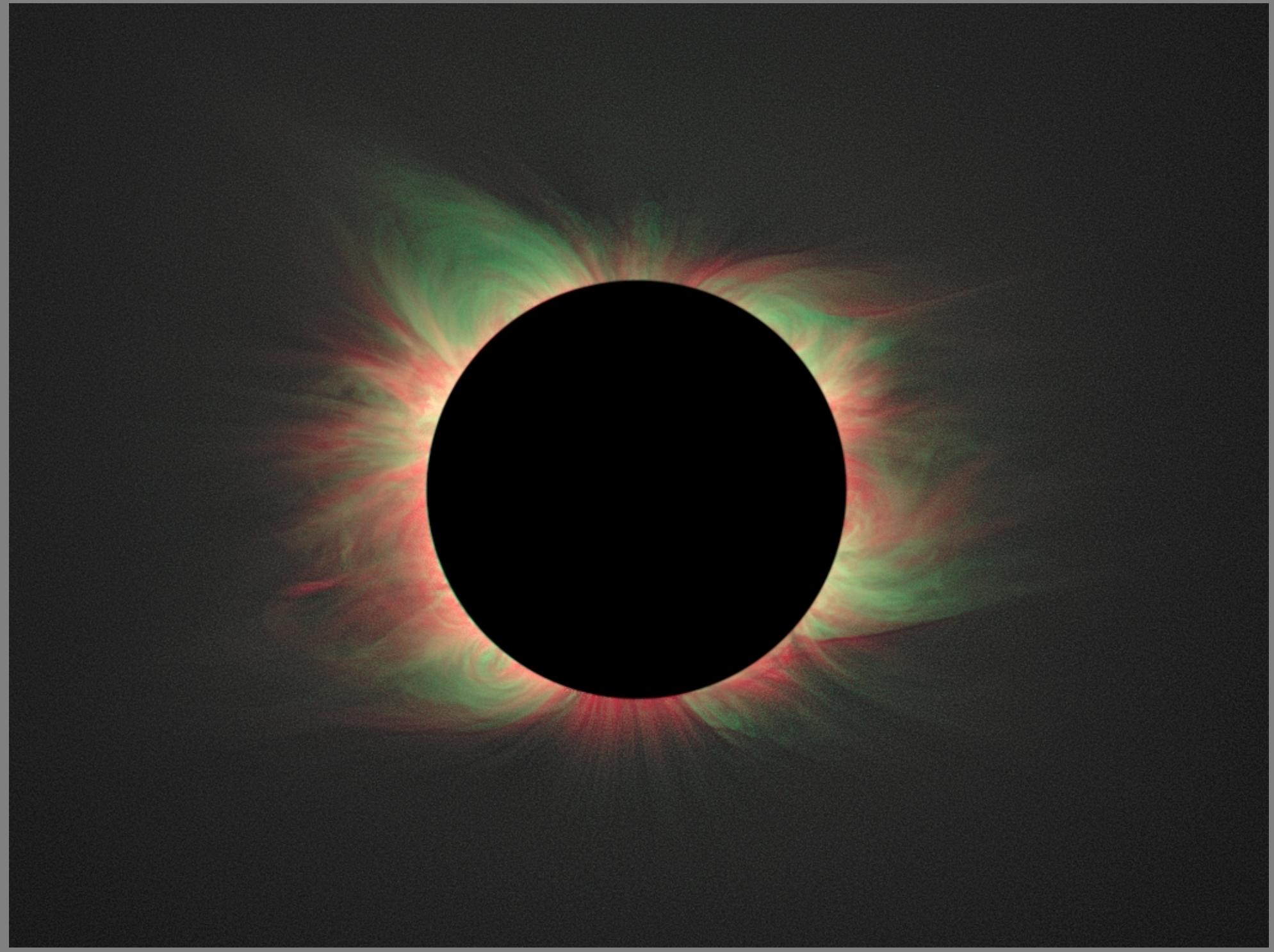


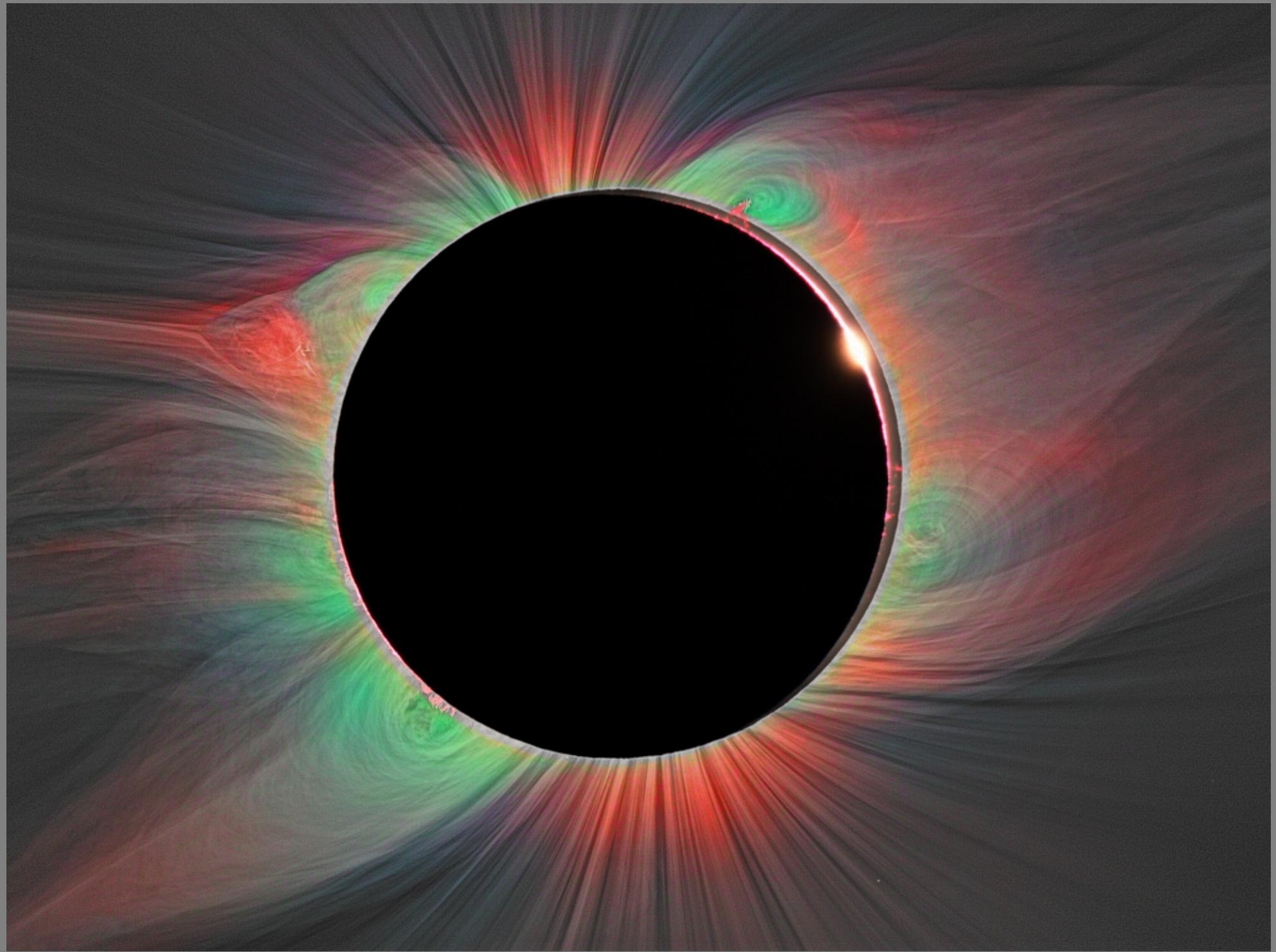
Table 1
Fe XV was not Observed but is Included for Comparison

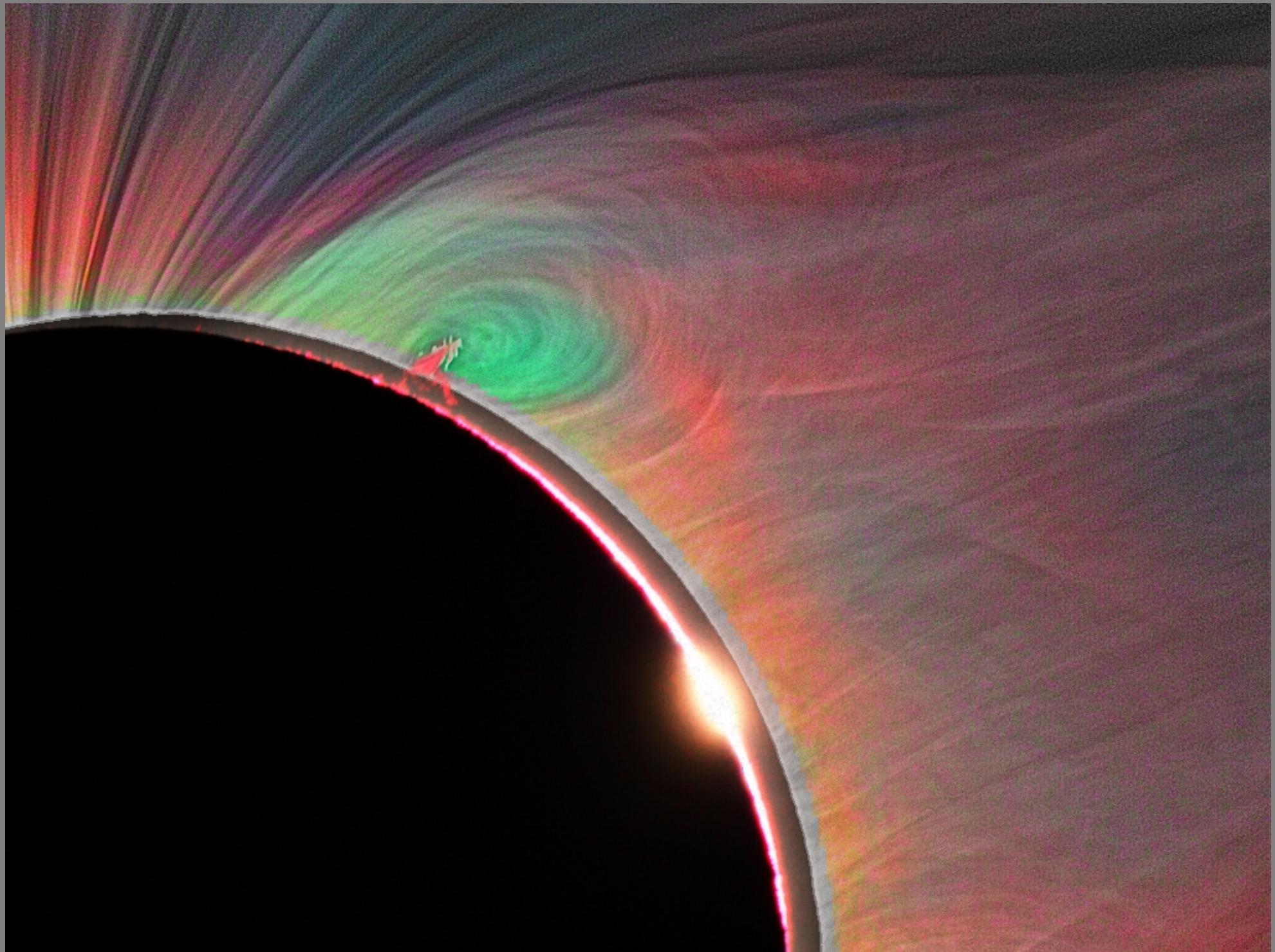
Spectral Line Ionization State	H α	Fe IX Fe ⁸⁺	Fe X Fe ⁹⁺	Fe XI Fe ¹⁰⁺	Fe XIII Fe ¹²⁺	Fe XIV Fe ¹³⁺	[Fe XV]* Fe ¹⁴⁺	Ni XV Ni ¹⁴⁺
λ (nm)	656.3	435.9	637.4	789.2	1074.7	530.30	705.86	670.17
T_{\max} (10^6 K)	0.02	0.5	0.8	1.16	1.6	1.8	2.5	2.5
E (eV)	13.6	233.6	262.1	290.2	361.0	392.2	457	464
A (s^{-1})	4.41×10^7	≈ 50	69.4	43.7	14	60.2	37.4	56.5
$I_{\odot}/I_{\odot}(500.2 \text{ nm})$	0.851	0.953	0.878	0.654	0.342	0.992	0.777	0.831
Min. exp. t (s)	0.002	0.05	0.05	0.08	1.05	0.05		0.05
Max. exp. t (s)	67.62	28.47	28.47	21.19	67.40	28.47		28.47

Notes. E is the ionization energy relative to the ionization state immediately below, i.e., from charge state i to $i + 1$. A is the transition probability. I_{\odot} is the intensity of the photosphere calculated from the Planck function, at a given wavelength, for a blackbody T of 5800 K, which peaks at 500.2 nm.

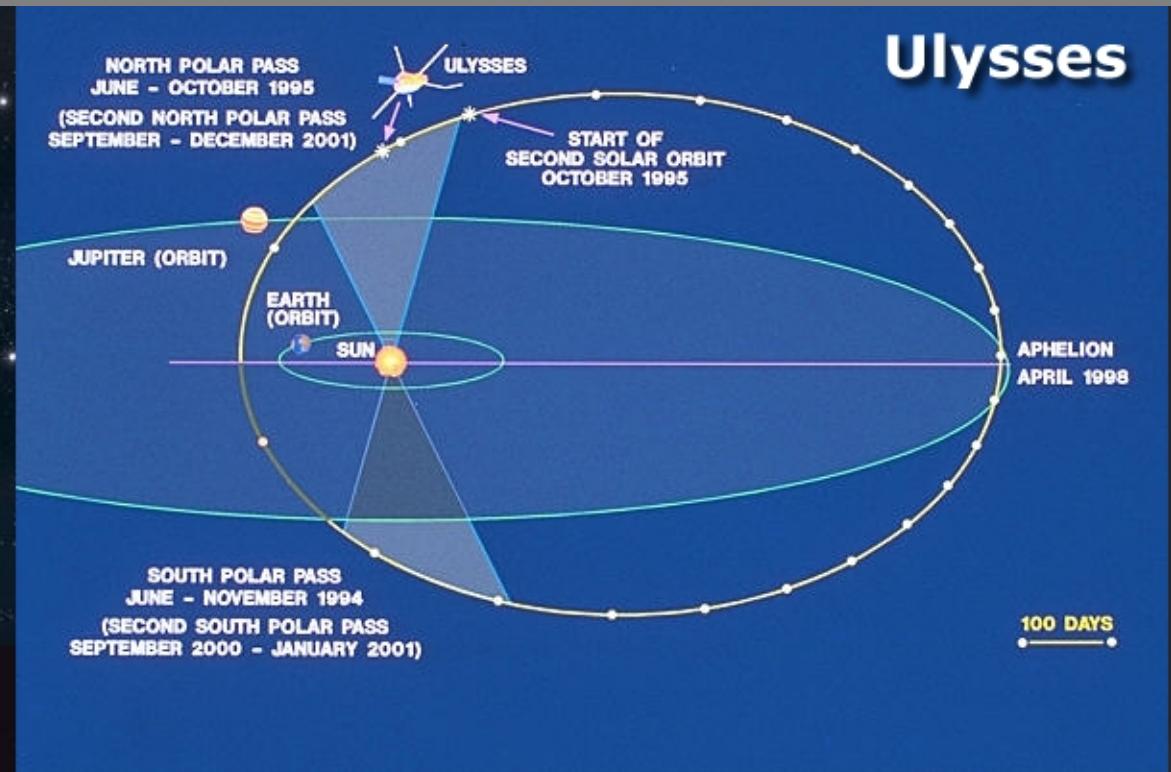






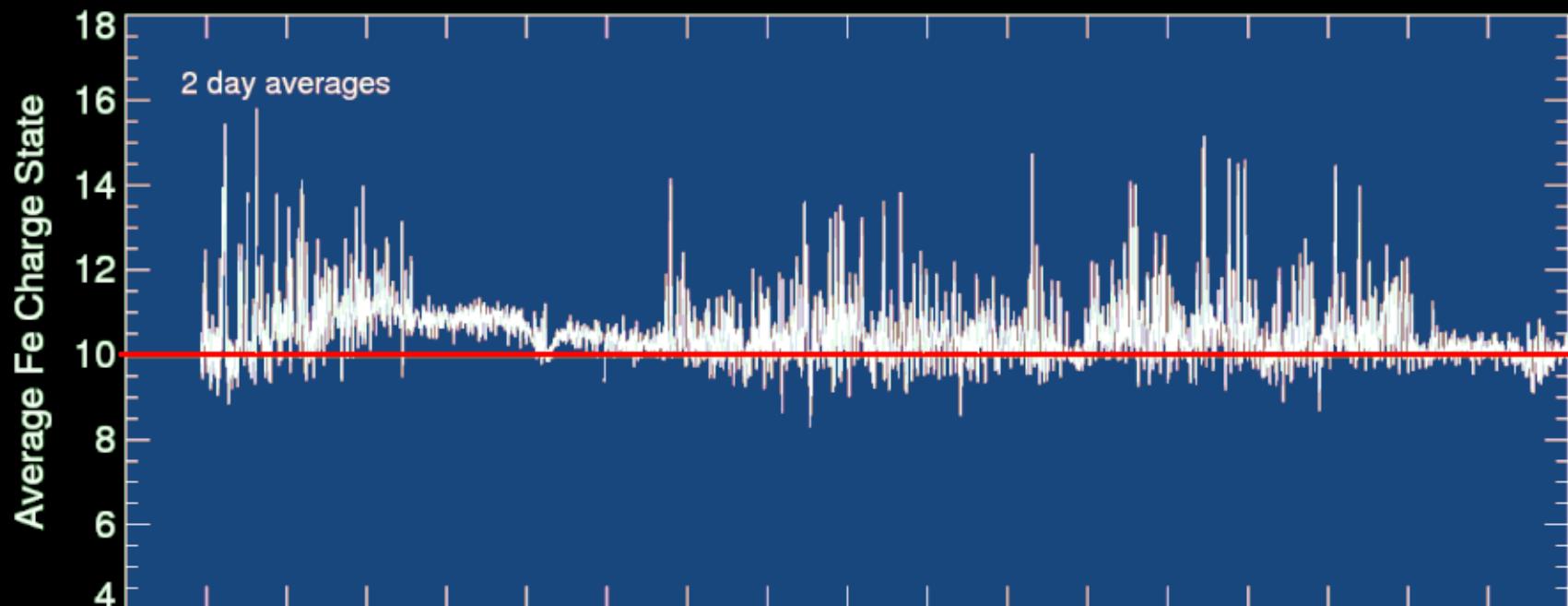


Ulysses



ESA ULYSSES DATA SYSTEM

SWICS



F-koróna





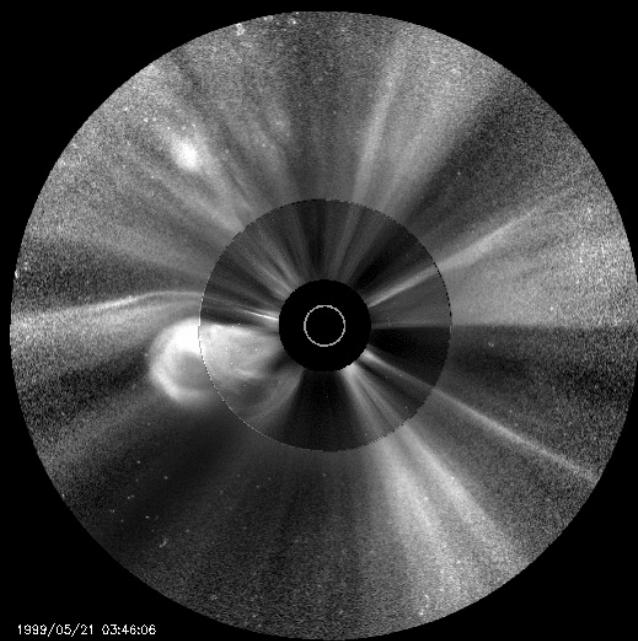






Kde končí sluneční koróna?



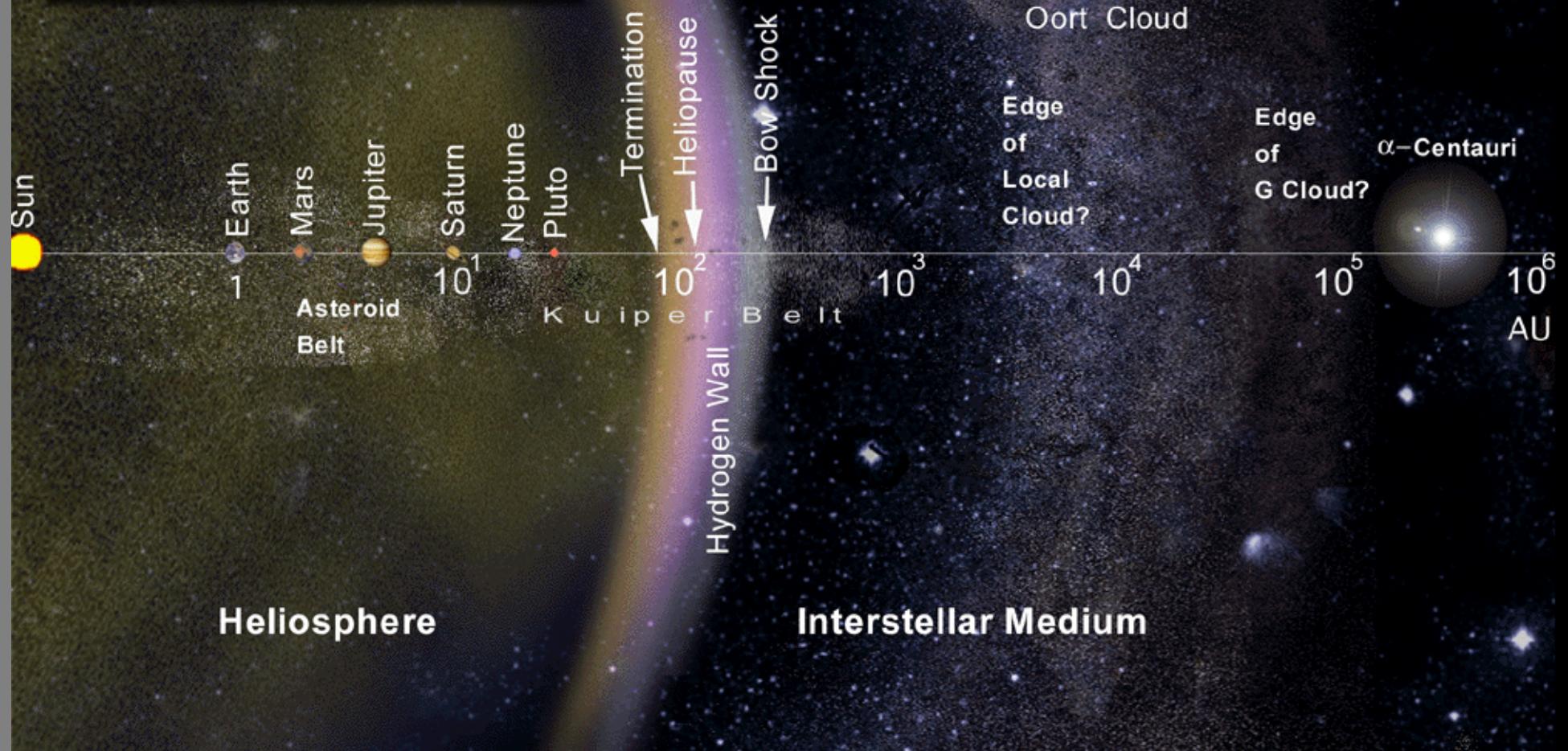
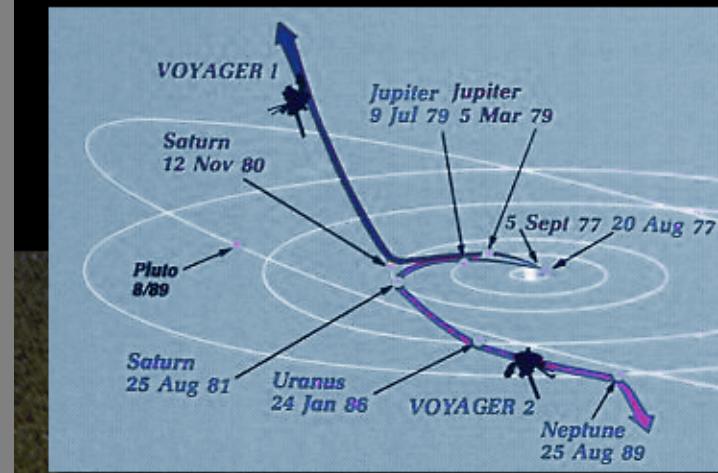


1999/05/21 03:46:06

Termination Shock

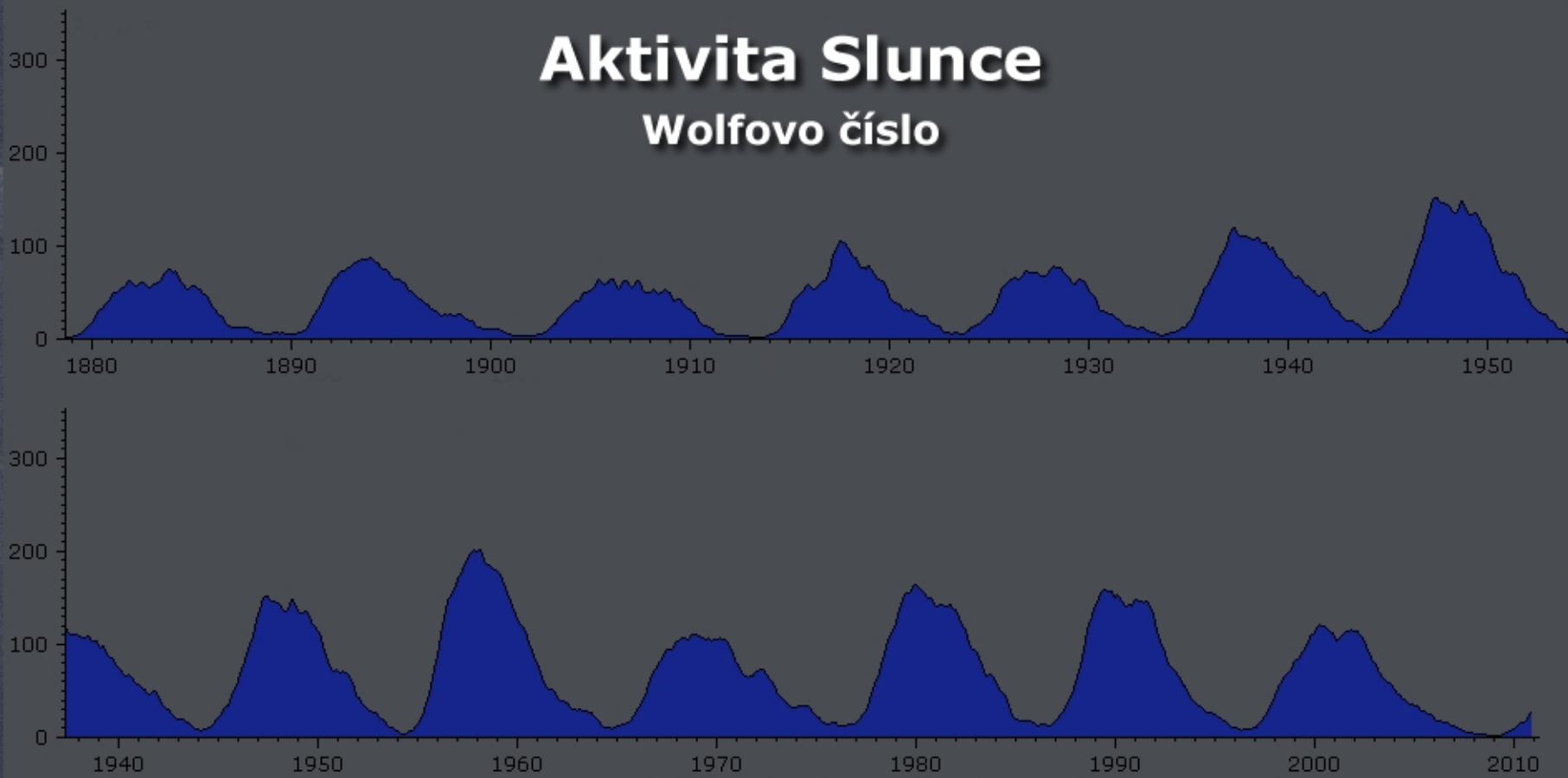
Voyager 1, 94 AU, 2004

Voyager 2, 84 AU, 2007

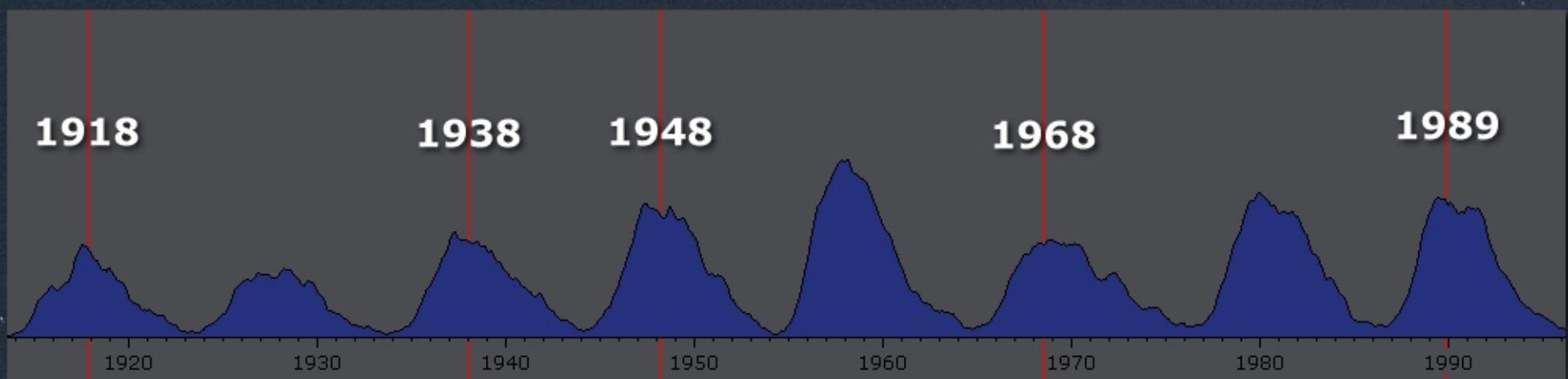
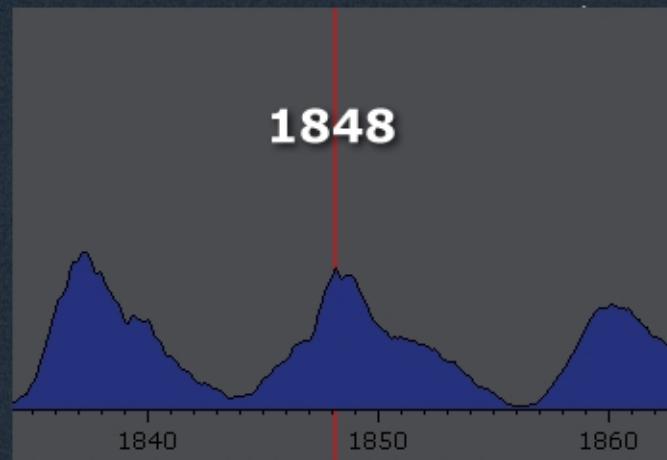


Aktivita Slunce

Wolfovo číslo



Má to být vědecká přednáška?



... tak raději bez komentáře

