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Kompjuterski softver i simulacije u nastavi fizike

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Akreditovani seminar "Sa krova do Zvezda"
4 – 5 decembar 2015, PMF, Niš

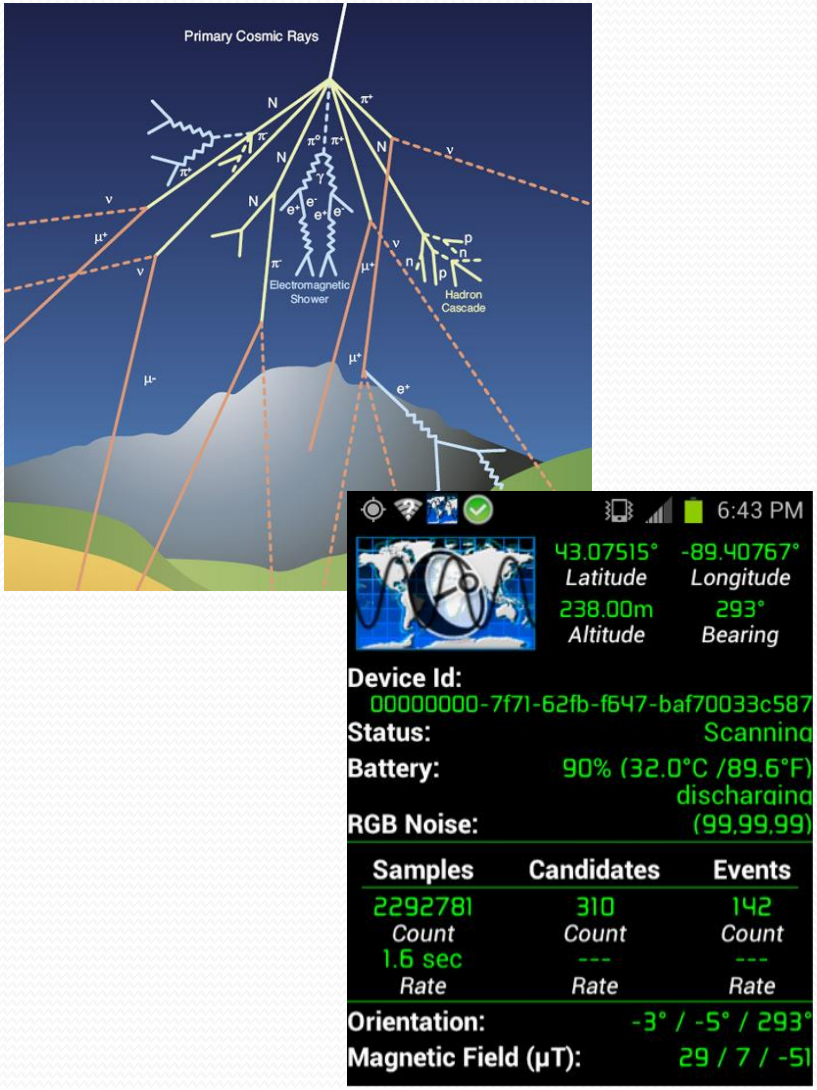
Program stalnog stručnog usavršavanja ZUOV, kat. br. 590

Android aplikacije

- Google Sky Map
- Night Sky Tools
- Projekat DECO
  - (Distributed Cosmic-ray Observatory)
  - http://wipac.wisc.edu/deco
- CRAYFIS
  - http://crayfis.io/

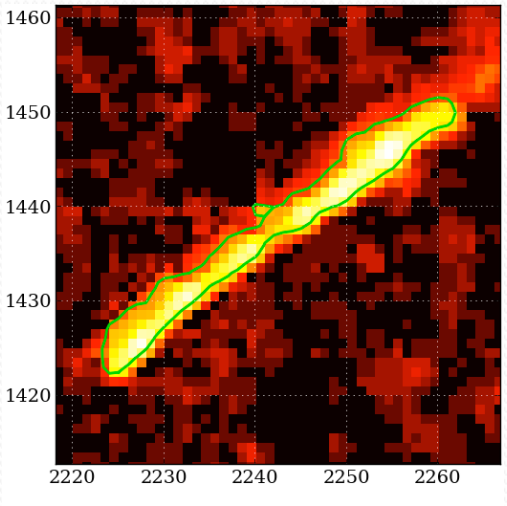
Projekat DECO

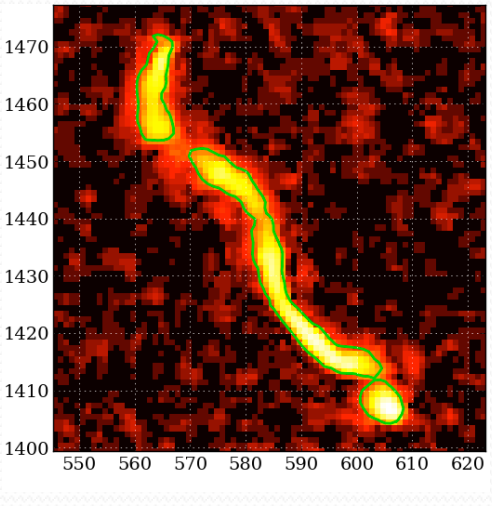
DECO
Distributed Electronic Cosmic-ray Observatory

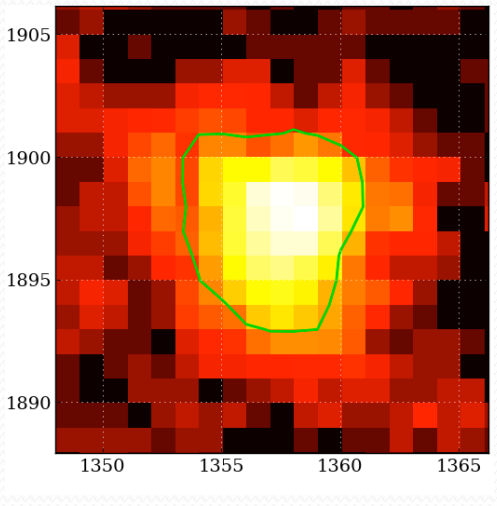


- Snima fotografije 1-2 sekunde
- Dovoljno sjajnih piksela – kandidat
- Nova analiza – proverava događaj
- Kosmičko zračenje – mioni
  - Drugi događaji: elektroni, gama zraci, alfa čestice (radioaktivno zračenje okoline)
- Nekoliko događaja za 24h

Projekat DECO - događaji





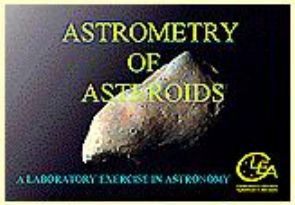


- Mion, kosmičko zračenje
- Elektron (radioaktivno zračenje, direktno ili gama zračenje koje je “pogodilo” elektron)
- Elektron ili gama zračenje

Projekat CLEA

- “Contemporary Laboratory Experiences in Astronomy”
- http://www3.gettysburg.edu/~marschal/clea/CLEAhome.html
- Podrška:
  - NASA
  - Gettysburg college
- Svaka vežba:
  - Program
  - Uputstvo za učenike
  - Tehničko uputstvo
- Posle 22 godine nema novih verzija ☹

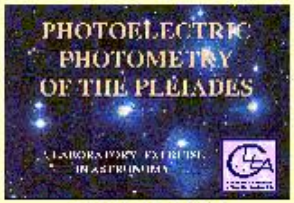
Radio Astronomy of Pulsars



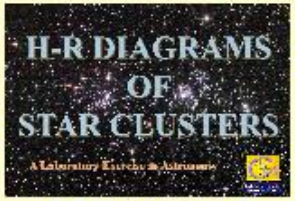
Astrometry of Asteroids

The Revolution of the Moons of Jupiter

The Rotation of Mercury by The Doppler Effect

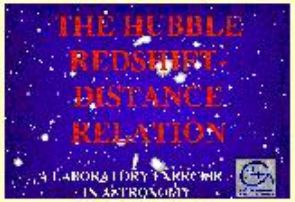


Photoelectric Photometry of the Pleiades



HR Diagrams of Clusters

Spectral Classification of Stars

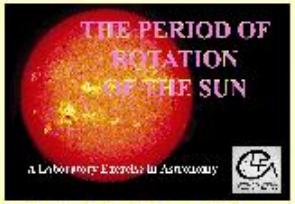


The Hubble Relation

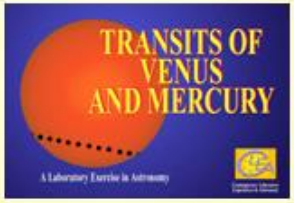
The Large Scale Structure of the Universe

Flow of Energy Out of the Sun

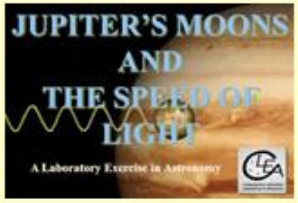
The Quest for Object X



Solar Rotation Using Images from the GONG Project



Transits of Venus and Mercury Using Images from the GONG project



Jupiter's Moons and the Speed of Light: The Classic Roemer Experiment

Dying Stars and the Birth of the Elements

The Height of Lunar Mountains (From an associated NON CLEA DEVELOPER)

VIREO

- The Virtual Educational Observatory
- Najnoviji program, objedinjuje mnogo prethodnih vežbi
  - simulira realno nebo
  - nekoliko miliona objekata
  - Vizuelni, radio i IC teleskop
  - Različita oprema (fotografija, fotometrija, spektrografija...)
  - Alati za analizu podataka

Pege i rotacija Sunca

Važne formule

$$P = \frac{365.25 * S}{S + 365.25}$$

$$S_{dani} = \frac{360^{o}}{nagib_{(stepen/danu)}}$$

P – siderički period
S – sinodički period

Merenje Hablove const.

Potrebne formule

$$M = m + 5 - 5 * \log D$$

$$\log D = \frac{m - M + 5}{5}$$

$$v_K = c * \frac{\Delta\lambda_K}{\lambda_K}$$

$$v_H = c * \frac{\Delta\lambda_H}{\lambda_H}$$

$$\Delta\lambda_K = \lambda_{K_{izmereno}} - \lambda_K$$

$$\Delta\lambda_H = \lambda_{H_{izmereno}} - \lambda_H$$

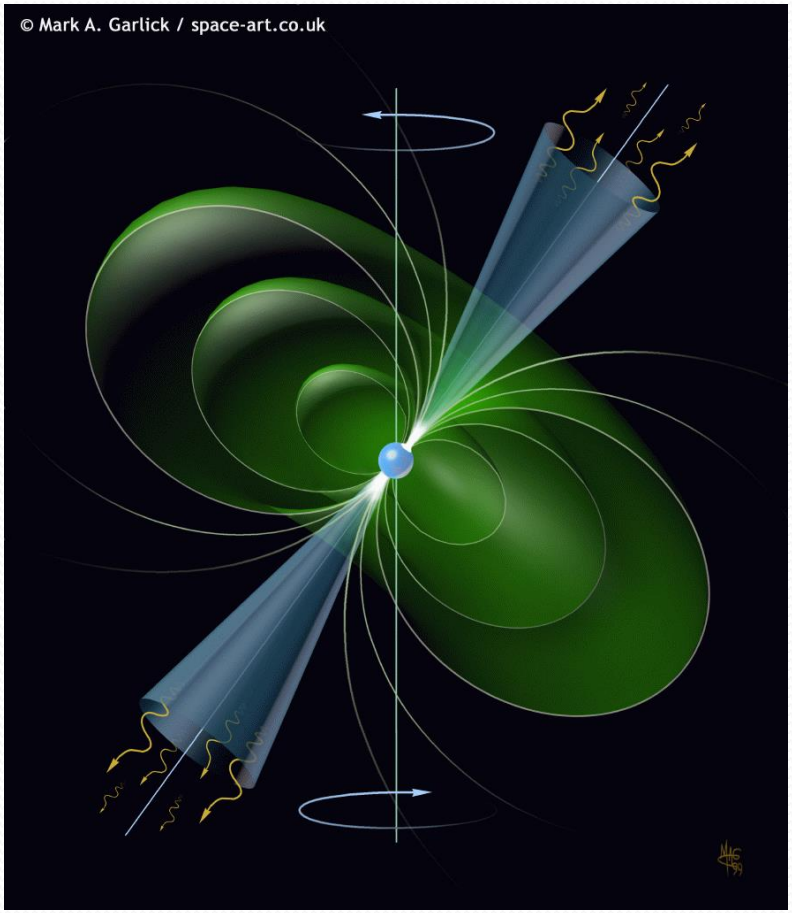
$$H = \frac{v}{D}$$

Starost svemira:

$$D = R * T \longrightarrow T = \frac{D}{R}$$

Radio astronomija pulsara

Pulsari



Radio teleskop

Određivanje rastojanja

- “disperzija” – različita brzina radio talasa u zavisnosti od sredine:
  - Međuzvezdani prostor nije vakuum, nekoliko atoma/elektrona u cm^3
  - Niža frekvenca – sporiji talasi
  - Viša frekvenca – brži talasi

“Obična” fizika

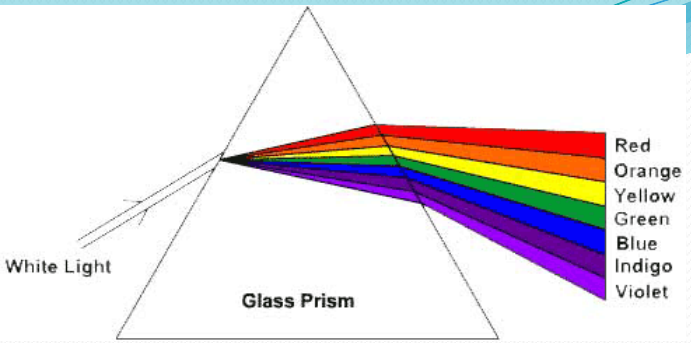
- Dva trkača
- **A**: 5 km/h, **B**: 10 km/h
- Rastojanje nije poznato, ali znamo da su krenuli istovremeno

$$T_A = \frac{L}{V_A}, T_B = \frac{L}{V_B}$$

$$T_B - T_A = \frac{L}{V_B} - \frac{L}{V_A}$$

$$L = \frac{T_B - T_A}{\left(1/V_B - 1/V_A \right)}$$

Rastojanje pulsara



- Brzina talasa:

$$v = \frac{f^2}{4150 \cdot n_e} = \frac{f^2}{124.5}$$

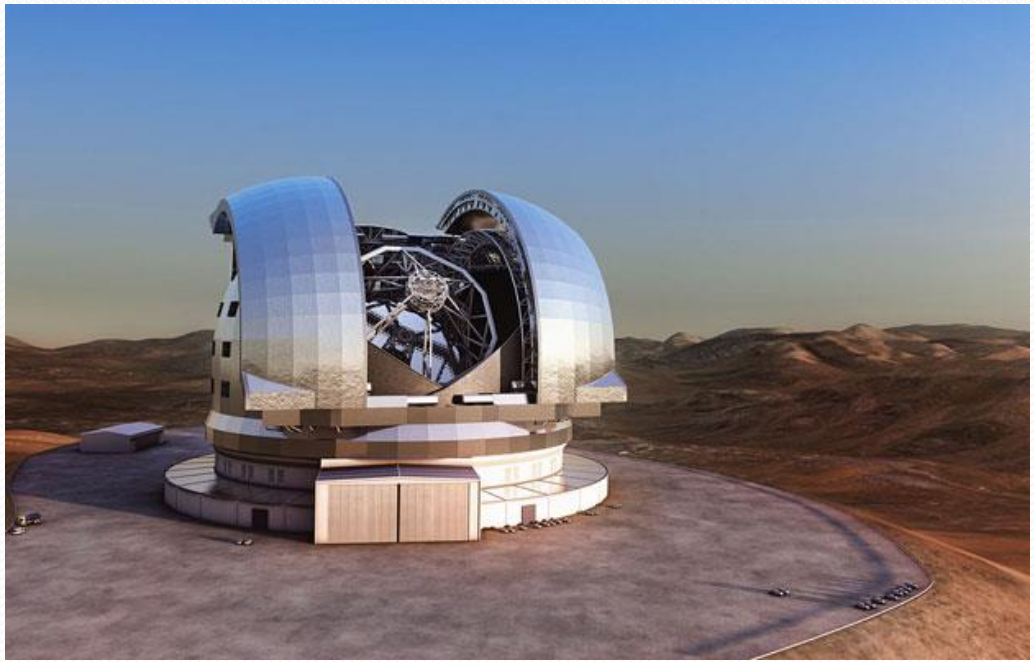
- n_e – gustina međuzvezdanog prostora, 0.03 el./cm³

- Rastojanje:

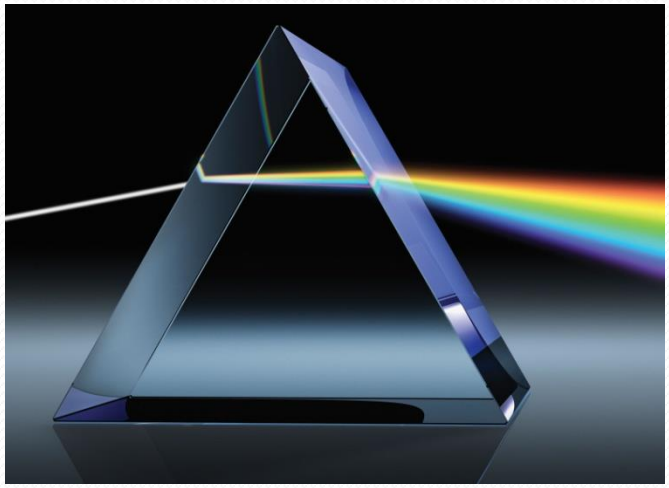
$$D = \frac{T_2 - T_1}{124.5 \cdot \left(\left(\frac{1}{f_2} \right)^2 - \left(\frac{1}{f_1} \right)^2 \right)}$$

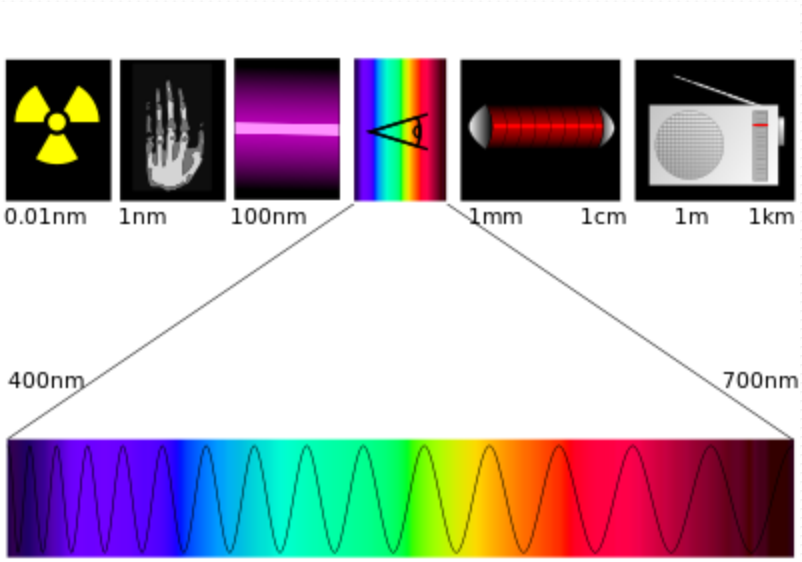
Klasifikacija zvezda

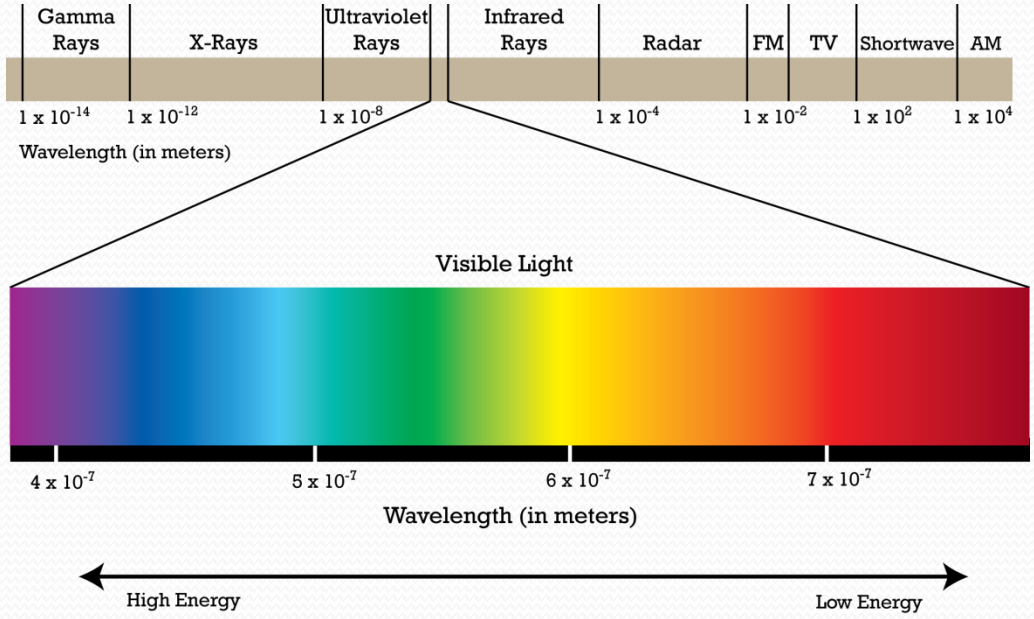
Teleskop



Spektar

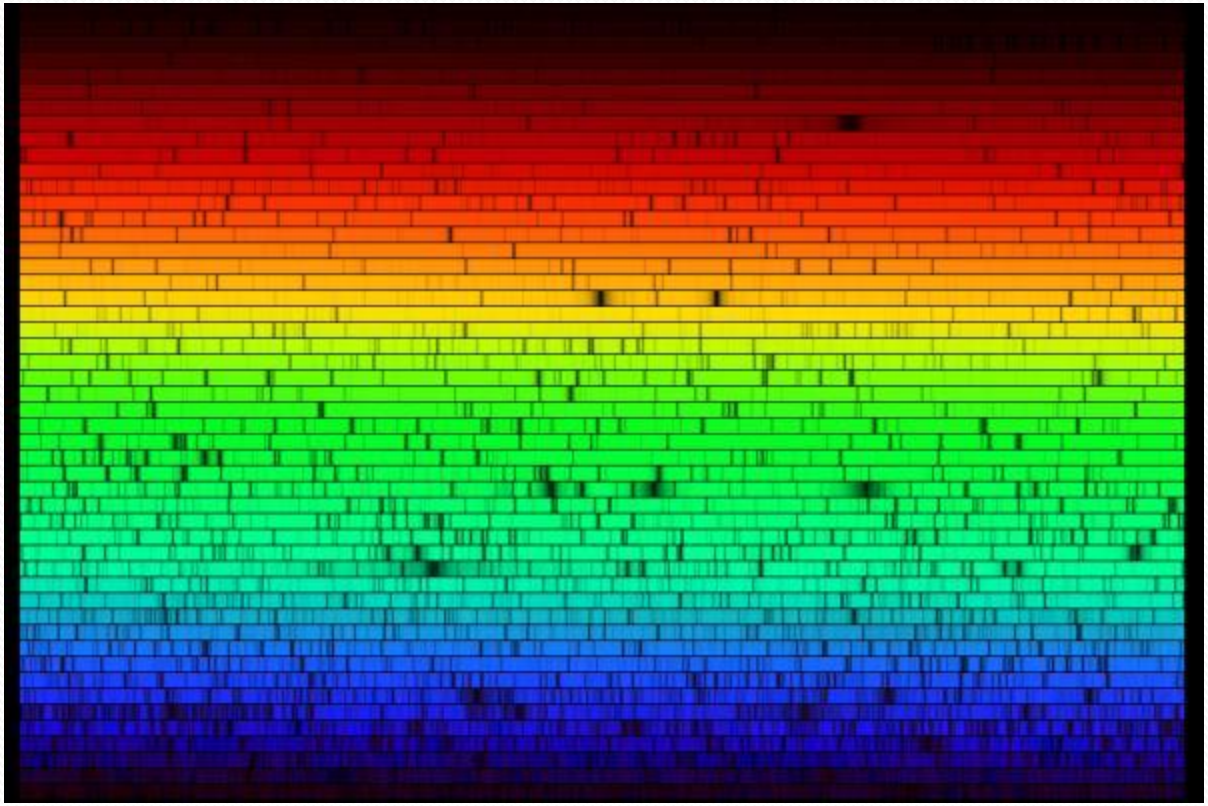



0.01nm
1nm
100nm
1mm
1cm
1m
1km
400nm
700nm

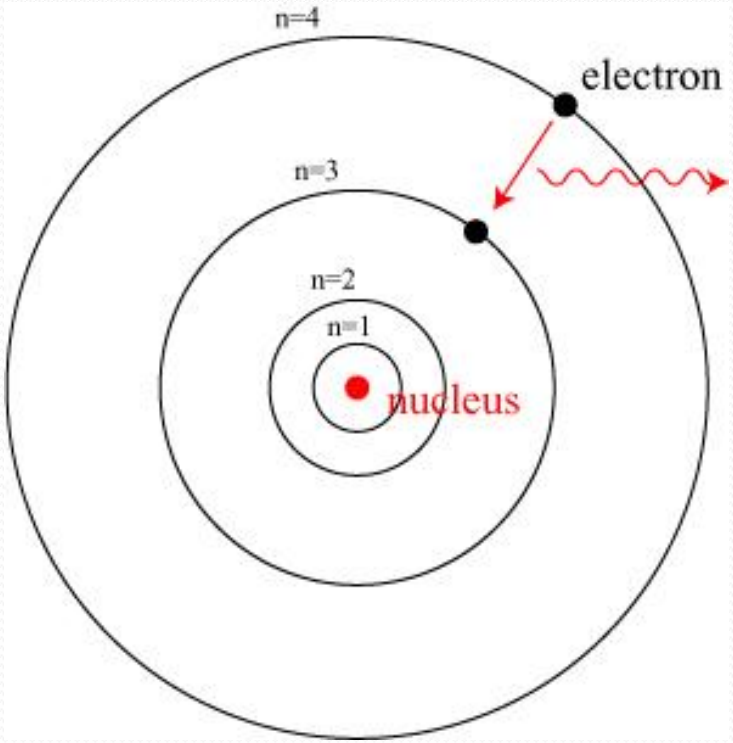

Gamma Rays
X-Rays
Ultraviolet Rays
Infrared Rays
Radar
FM
TV
Shortwave
AM
1 x 10-14
1 x 10-12
1 x 10-8
1 x 10-4
1 x 10-2
1 x 102
1 x 104
Wavelength (in meters)
Visible Light
4 x 10-7
5 x 10-7
6 x 10-7
7 x 10-7
Wavelength (in meters)
High Energy
Low Energy

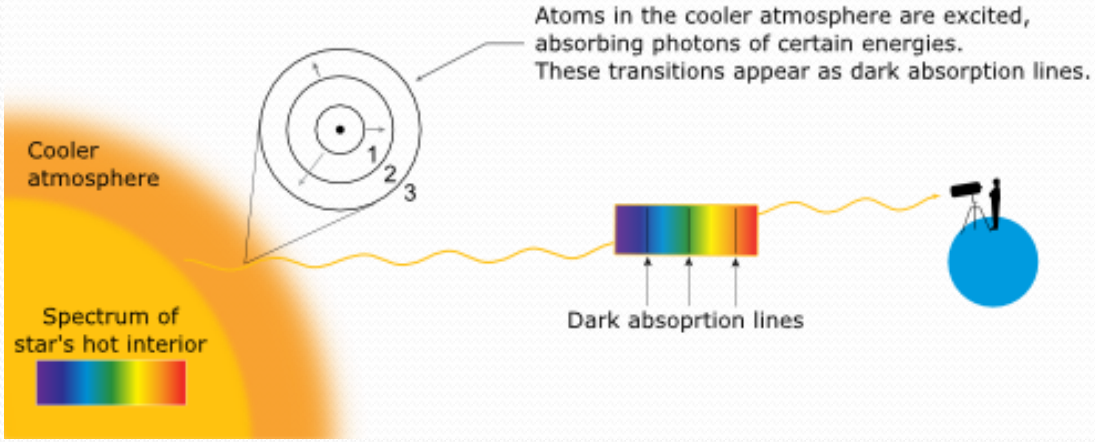
Spektri zvezda

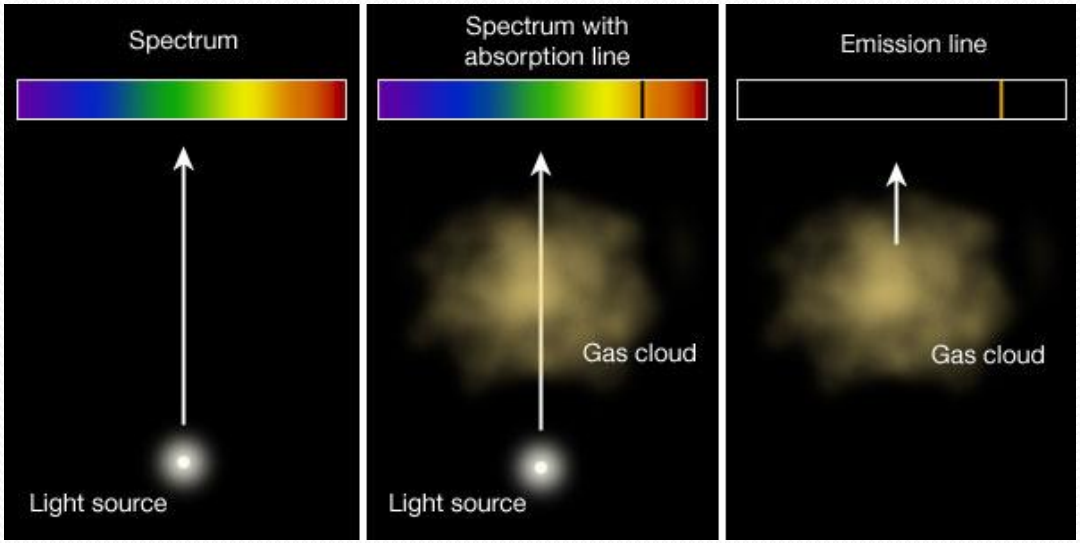
- 1870. godina, Joseph von Fraunhofer



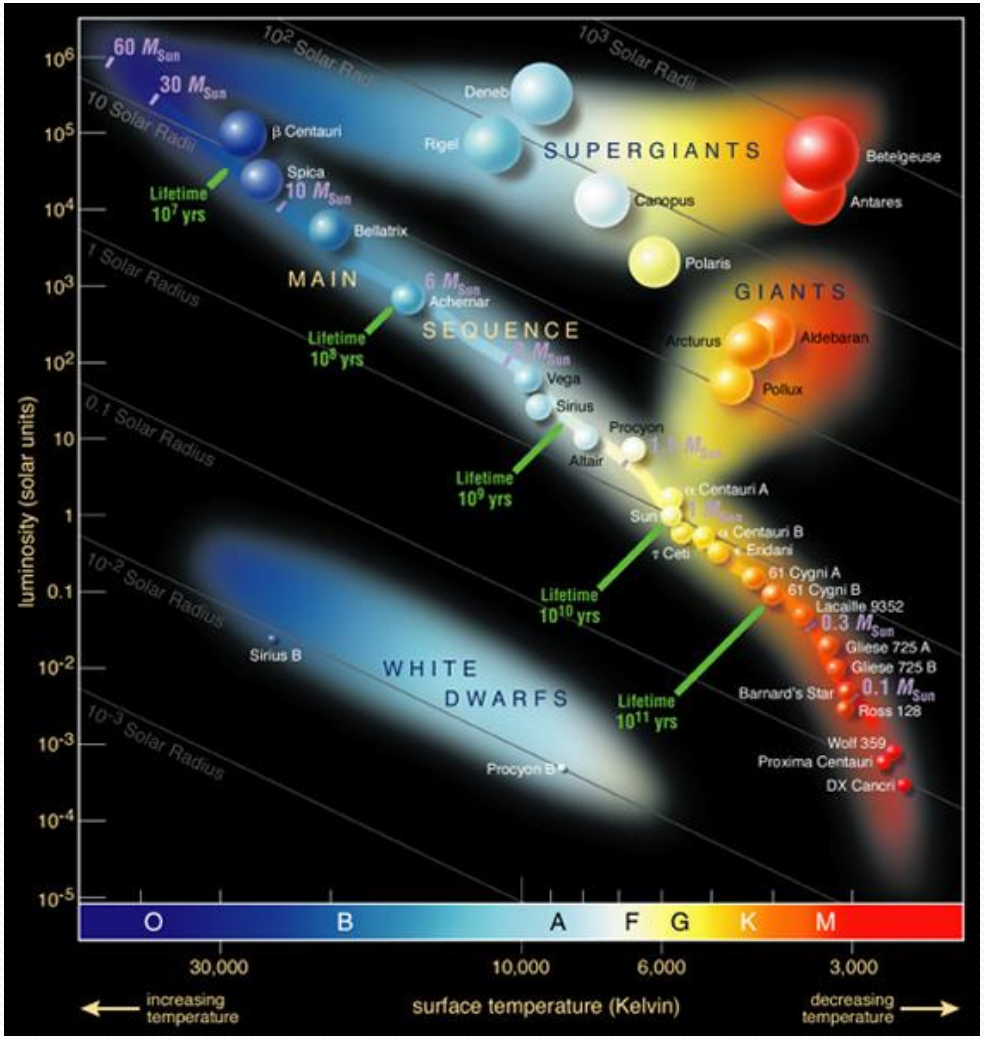
Kako nastaju?







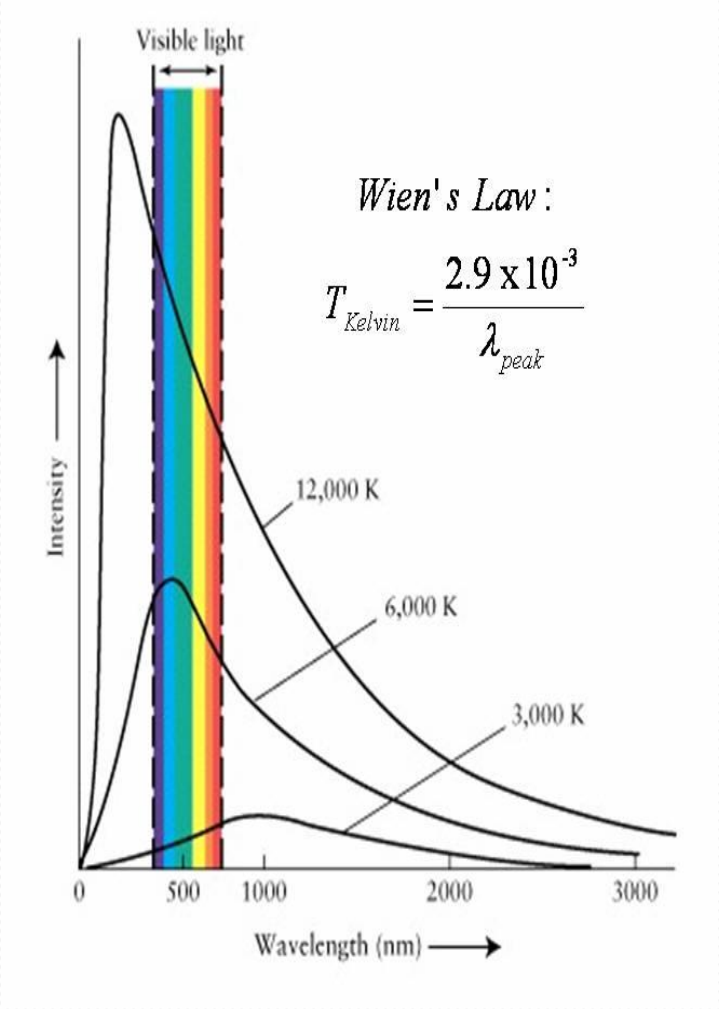
Hertzsprung–Russell diagram



Zvezde

- **Sirius**
  - Ra. 06h 45m 08, Dec. –16° 42′ 58
  - Klasa: A1V; rastojanje: ~2.5pc; temp: ~10000K
  - http://en.wikipedia.org/wiki/Sirius
- **Betelgeuse**
  - Ra. 05h 55m 10, Dec. +07° 24′ 25
  - Klasa: M2I; rastojanje: ~200pc; temp: ~3400K;
  - http://en.wikipedia.org/wiki/Betelgeuse
- Algol
  - Ra. 03h 08m 10, Dec. +40° 57′ 20
  - Klasa: B8V, rastojanje: ~30pc, temp: ~9000K
  - http://en.wikipedia.org/wiki/Algol

Vinov zakon



Classification	Temperature	Max Wavelength	Color
O0	40,000 K	72.5 nm	Blue
B0	20,000 K	145 nm	Light Blue
A0	10,000 K	290 nm	White
F0	7,500 K	387 nm	Yellow-White
G0	5,500 K	527 nm	Yellow
K0	4,000 K	725 nm	Orange
M0	3,000 K	966 nm	Red

Određivanje temerature zvezde

Main sequence stars (V)

Spectral Type	Temperature (K)	Absolute Magnitude	Luminosity (in solar luminosities)
O5	54,000	-4.5	200,000
O6	45,000	-4.0	140,000
O7	43,300	-3.9	120,000
O8	40,600	-3.8	80,000
O9	37,800	-3.6	55,000
B0	29,200	-3.3	24,000
B1	23,000	-2.3	5550
B2	21,000	-1.9	3190
B3	17,600	-1.1	1060
B5	15,200	-0.4	380
B6	14,300	0	240
B7	13,500	0.3	140
B8	12,300	0.7	73
B9	11,400	1.1	42
A0	9600	1.5	24
A1	9330	1.7	20
A2	9040	1.8	17
A3	8750	2.0	14
A4	8480	2.1	12
A5	8310	2.2	11
A7	7920	2.4	8.8
F0	7350	3.0	5.1
F2	7050	3.3	3.8
F3	6850	3.5	3.2
F5	6700	3.7	2.7
F6	6550	4.0	2.0
F7	6400	4.3	1.5
F8	6300	4.4	1.4
G0	6050	4.7	1.2
G1	5930	4.9	1.1
G2	5800	5.0	1
G5	5660	5.2	0.73
G8	5440	2.6	0.51

$$\log D = \frac{m - M + 5}{5}$$

$$D = 10^{\log D}$$

K0	5240	6.0	0.38
K1	5110	6.2	0.32
K2	4960	6.4	0.29
K3	4800	6.7	0.24
K4	4600	7.1	0.18
K5	4400	7.4	0.15
K7	4000	8.1	0.11
M0	3750	8.7	0.080
M1	3700	9.4	0.055
M2	3600	10.1	0.035
M3	3500	10.7	0.027
M4	3400	11.2	0.022
M5	3200	12.3	0.011
M6	3100	13.4	0.0051
M7	2900	13.9	0.0032
M8	2700	14.4	0.0020
L0	2600	*	0.00029
L3	2200	*	0.00013
L8	1500	*	0.000032
T2	1400	*	0.000025
T6	1000	*	0.0000056
T8	800	*	0.0000036

*- not visible to the human eye (for the most part)

Giants (III)

Spectral Type	Temperature (K)	Absolute Magnitude	Luminosity (in solar luminosities)
G5	5010	0.7	127
G8	4870	0.6	113
K0	4720	0.5	96
K1	4580	0.4	82
K2	4460	0.2	70
K3	4210	0.1	58
K4	4010	0.0	45
K5	3780	-0.2	32
M0	3660	-0.4	15
M1	3600	-0.5	13
M2	3500	-0.6	11
M3	3300	-0.7	9.5
M4	3100	-0.75	7.4
M5	2950	-0.8	5.1
M6	2800	-0.9	3.3

$$\log D = \frac{m - M + 5}{5}$$

$$D = 10^{\log D}$$

Supergiants (I)

Spectral Type	Temperature (K)	Absolute Magnitude	Luminosity (in solar luminosities)
B0	21,000	-6.4	320,000
B1	16,000	-6.4	280,000
B2	14,000	-6.4	220,000
B3	12,800	-6.3	180,000
B5	11,500	-6.3	140,000
B6	11,000	-6.3	98,000
B7	10,500	-6.3	82,000
B8	10,000	-6.2	73,000
B9	9700	-6.2	61,000
A0	9400	-6.2	50,600
A1	9100	-6.2	44,000
A2	8900	-6.2	40,000
A5	8300	-6.1	36,000
F0	7500	-6	20,000
F2	7200	-6	18,000
F5	6800	-5.9	16,000
F8	6150	-5.9	12,000
G0	5800	-5.9	9600
G2	5500	-5.8	9500
G5	5100	-5.8	9800
G8	5050	-5.7	11,000
K0	4900	-5.7	12,000
K1	4700	-5.6	13,500
K2	4500	-5.6	15,200
K3	4300	-5.6	17,000
K4	4100	-5.5	18,300
K5	3750	-5.5	20,000
M0	3660	-5.3	50,600
M1	3600	-5.3	52,000
M2	3500	-5.3	53,000
M3	3300	-5.3	54,000
M4	3100	-5.2	56,000
M5	2950	-5.2	58,000