

Capturing Dynamic Astronomical Objects

From Supernovas to Moving Stars, Eclipses and Occultations

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March 10, 2026



Me and My Telescopes



Move equipment outside.



Ready To Go...

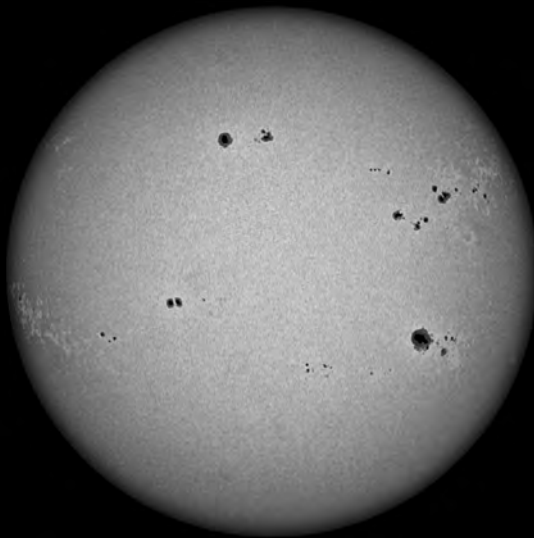


10" Reflector, 4" Refractor, Telephoto Lens



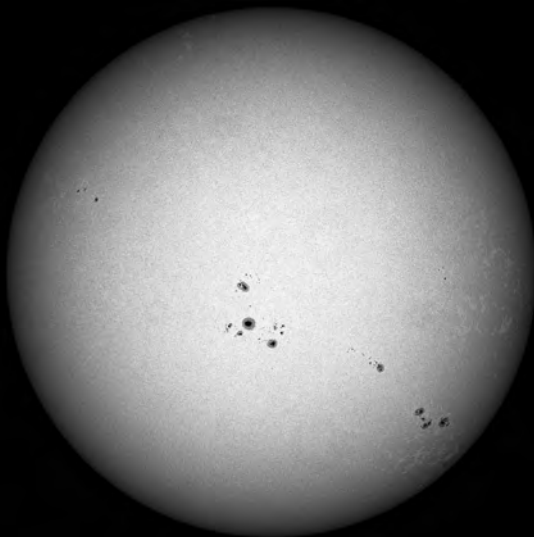
Sun with Sunspots

Jan 16, 2023



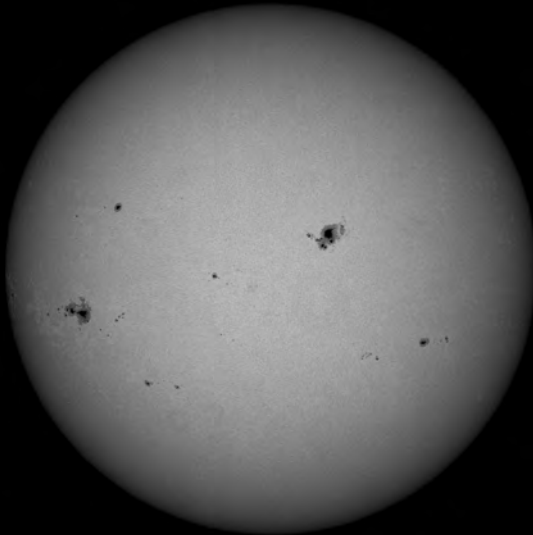
Sun with Sunspots

May 22, 2024



Sun with Sunspots

Aug 13, 2024



Solar Eclipse: Partial Phases – 2024



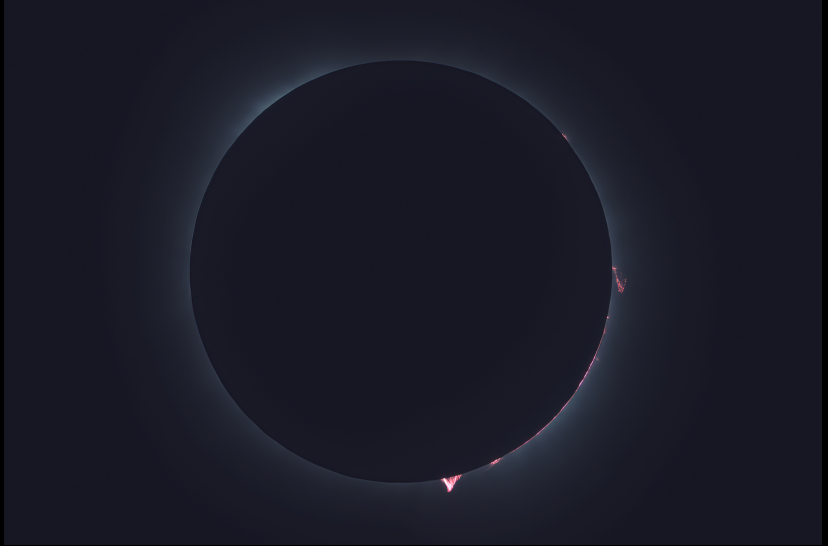
Solar Eclipse: Jet Stream



Video taken by Aram Friedman



Solar Eclipse: Totality – 2024



Crescent Moon



Crescent Moon



Crescent Moon



Crescent Moon

4:07pm Nov. 5, 2021



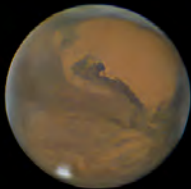
Full Moon

1.2 sec



Mars

Oct. 6 and 18, 2020



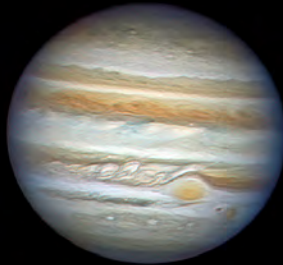
Moon and Mars

Jan. 13, 2025



Jupiter and Saturn

32 and 67 min



Jupiter and its Galilean Moons



Comet 103P / Double Cluster

1.2 min / 7460 and 7640 yrs



Comet 103P / Double Cluster

55 minutes in 10 seconds



Comet Tsuchinshan

7:17 pm, Oct. 15 2024

4.1 min



Aurora Borealis (aka Northern Lights)

7:20pm, Oct. 11 2024



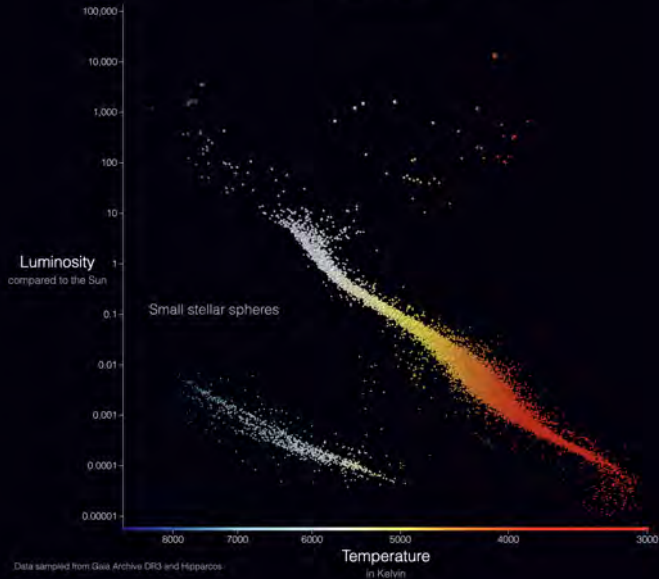
Looking Out Beyond Our Solar System



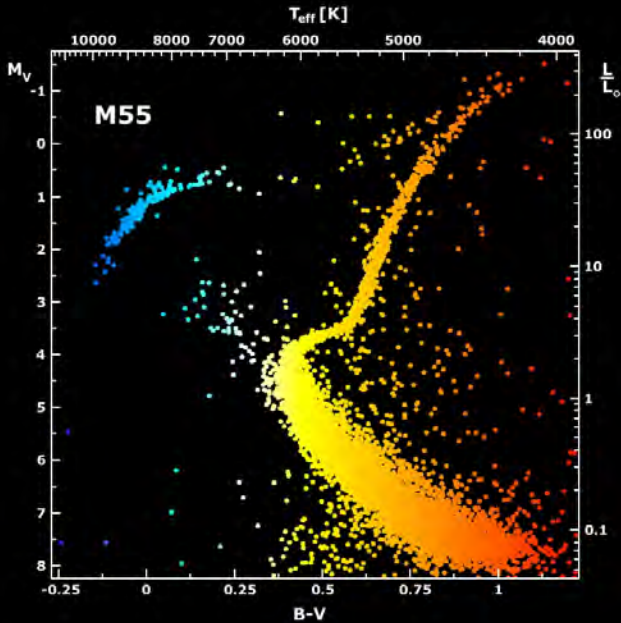
Color/Magnitude Diagram

Hertzprung-Russell Diagram

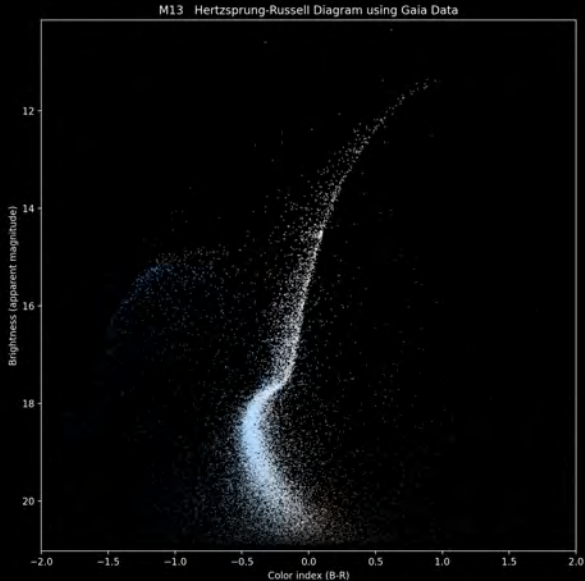
All stars within 40pc



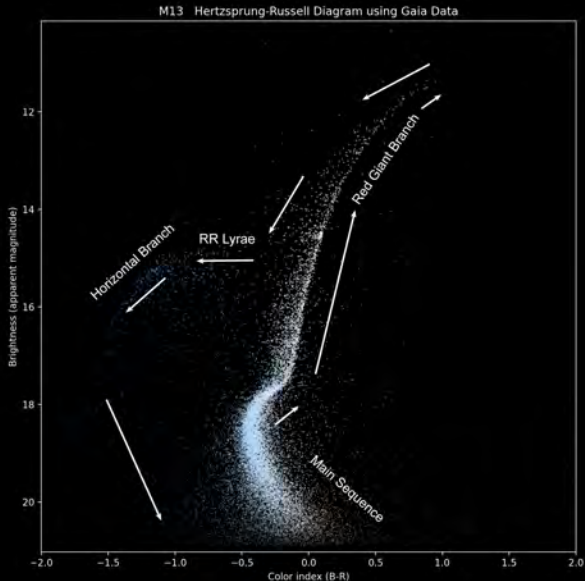
Variable Stars



HR-Diagram Using Gaia Data



HR-Diagram Using Gaia Data



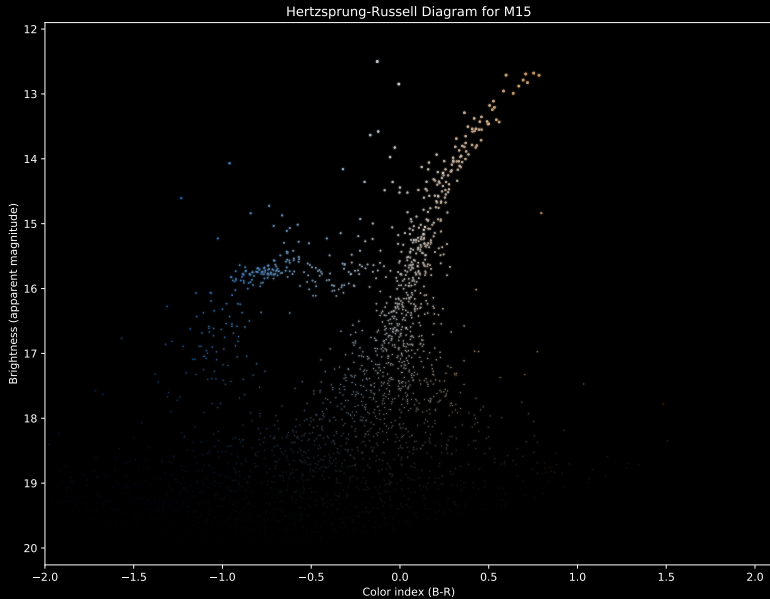
Globular Cluster M15

[Click to see it](#)



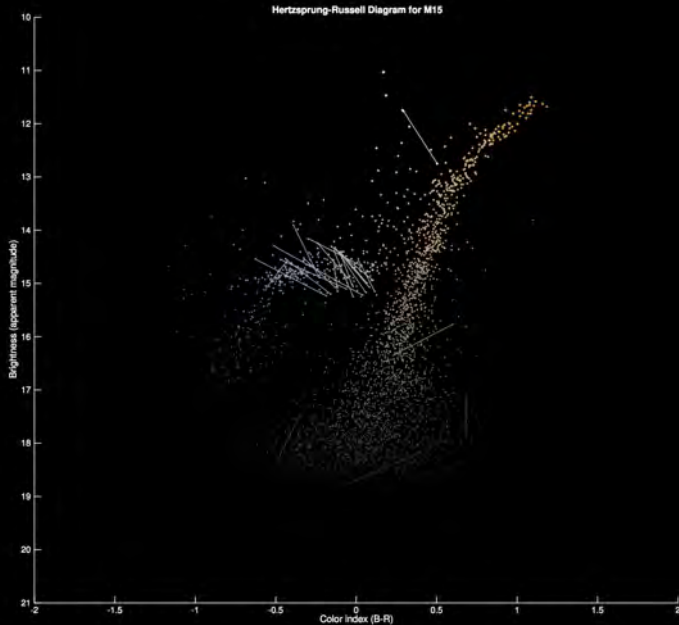
HR-Diagram for M15

[Click to see it](#)



HR-Diagram Showing RR-Lyrae Stars

[Click to see it](#)



RR-Lyrae

distance: 258 parsecs



RR-Lyrae

distance: 258 parsecs



Dumbbell Nebula: M27

Mira Variable Stars



Dumbbell Nebula: M27

Mira Variable Stars



Proper Motion and Parallax



Barnards Star – Click To See Motion



Data from StackImages.py

| Date | t (years) | x (pixels) | y (pixels) |
|------------|----------------|-----------------|-----------------|
| 2012-06-21 | -0.494 | 758.95 | 649.41 |
| 2013-06-06 | 0.461 | 758.24 | 665.87 |
| 2013-09-05 | 0.715 | 756.69 | 669.24 |
| 2014-04-10 | 1.307 | 758.11 | 679.03 |
| 2014-07-05 | 1.547 | 756.82 | 684.50 |
| 2014-10-27 | 1.844 | 756.31 | 690.32 |

$$x(t) = x_0 + v_x t + a \sin(2\pi t)$$

$$y(t) = y_0 + v_y t + b \cos(2\pi t)$$

▶ t is time in years

▶ Unknowns: x_0 , v_x , a , y_0 , v_y , and b

▶ 1 pixel = 0.575 arcseconds

▶ a = parallax

▶ $\sqrt{v_x^2 + v_y^2}$ = proper motion

▶ $\tan^{-1}(b/a)$ = orbital inclination

$$\text{distance} = 1/\text{parallax} = 1.90 \text{ parsec}$$

$$\text{proper motion} = 9.9 \text{ arcsec/yr}$$



Year: 5405



Resume

Now

FOV: 90°



Max magnitude: 10.0

10.0

Show Constellation Lines

Show Star Labels

Stars Moving Over Time

Use the sliders to change year & FOV. Click anywhere in the view to re-center.

Click [here](#) to see a stereoscopic 3D rendition.

To change the view point, either type an Object Name (M, NGC, IC, or HD):

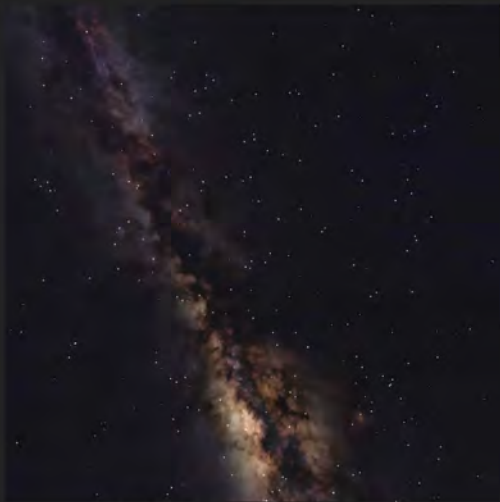
Barnard's Star

or give a Direction to Look:

or enter RA and Dec coordinates

RA: Dec:

or just click somewhere.



Note: Barnard's Star is being shown as magnitude 1 when in reality it is magnitude 9.5.



Supernovas



Crab Nebula: M1

Oct. 27, 2006

6500 yrs



Crab Nebula: M1

Mar. 26, 2019

6500 yrs



Crab Nebula – Analysis

First picture was taken Oct. 27, 2006.



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If we denote the expansion factor by x and we assume a constant linear rate of expansion, then the formula for computing the date at which the supernova explosion took place is

$$\text{date} = 2019 - \frac{4533}{365.25} \frac{1 + x}{x}$$



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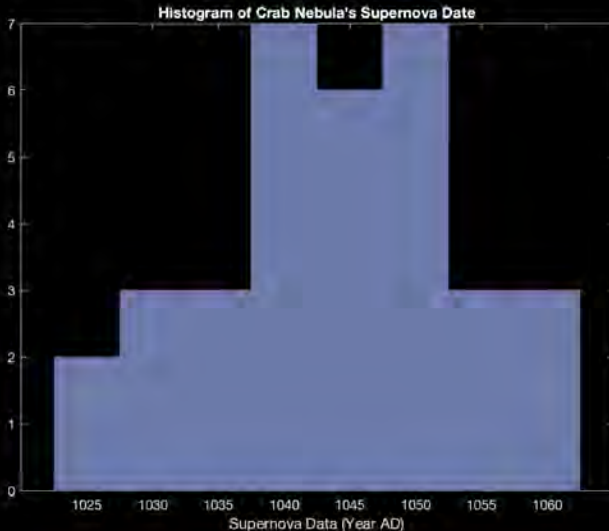
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According to the historical record, the supernova took place in the year 1054.



I recomputed the estimate by subsampling the measurements 34 different ways. Here's the histogram showing the range of dates obtained:



The Whirlpool Galaxy: M51

May 9, 2005



The Whirlpool Galaxy: M51

July 10, 2005



The Whirlpool Galaxy: M51

June 7, 2011



The Pinwheel Galaxy: M101

May 25, 2023



The Pinwheel Galaxy: M101

May 25, 2023



No More Dynamics. Just Pictures.



Helix Nebula: NGC 7293

200 yrs



The Pleiades (Subaru): M45

444 yrs



Pacman Nebula: NGC 281

950 yrs



Horsehead Nebula: IC 434

1260 yrs



Orion Nebula: M42

1344 yrs



Running Man Nebula: NGC 1977

1500 yrs



Crystal Ball Nebula: NGC 1514

1520 yrs



Veil Nebula: NGC 6960 and 6992

2400 yrs



Western Veil: NGC 6960

2400 yrs



Eastern Veil: NGC 6992



Owl Nebula: M97

2400 yrs



Ring Nebula: M57

2567 yrs



The Lagoon Nebula: M8

4100 yrs



Trifid Nebula: M20

4100 yrs



Crescent Nebula: NGC 6888

5000 yrs



Jellyfish Nebula: IC 443

5000 yrs



Rosette Nebula: NGC 2237

5200 yrs



Eagle Nebula: M16

5700 yrs



NGC 6820

6000 yrs



Eskimo Nebula: NGC 2392

6520 yrs



Bubble Nebula: NGC 7635

9100 \pm 2000 yrs



Globular Cluster: M13

22200 yrs



Looking Out Beyond Our Milky Way



The Andromeda Galaxy: M31

2450000 yrs



Sombrero Galaxy: M104

9600000 yrs



M81 and M82

11800000 yrs



Cigar Galaxy: M82

12000000 yrs



Galaxy Cluster: M106

24000000 yrs



The Leo Trio: M65, M66, NGC 3628

32000000 yrs



The Needle Galaxy: NGC 4565

42700000 yrs



Welcome to the Universe in 3D



Welcome to the Universe in 3D
A Visual Tour

By Neil deGrasse Tyson, Michael E. Brown

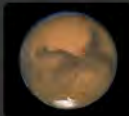
Illustrations by Dan Brulman



3D Pictures from the Book



Moon



Mars



Comet Lovejoy



Jupiter and Ganymede



Mimas



Crab Nebula



Andromeda



Hubble Ultra Deep Field



Questions?

