nightwatch

Newsletter of the Pomona Valley Amateur Astronomers

Is it not careless to become too local when there are four hundred billion stars in our galaxy alone.
. A. R. Ammons

VIRTUAL CLUB EVENTS
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Volume 40 Number 10 ***nightwatch*** **October 2020**

Betelgeuse Distance From Earth

As many of you may have seen by now, yet another attempt to figure out the distance to the red supergiant star Betelgeuse has been published (see the 3rd & 4th slides below). However, being the most recent publication, is not by itself a necessary indicator of greater fidelity to reality. One must not be too attracted to the definitive headlines declaring that Betelgeuse *is* (as opposed to *may* *be*) a lot closer than we thought.

First, allow me to point out that in astronomy, distances are never measured, in the direct sense that you may be used to. Something else is directly measured, and the distance is derived from that measurement, by some handy-dandy mathematical tool, and there are a lot of ways to do that.

The images here are all slides from my talks on stars, and on Betelgeuse in particular. The 1st slide illustrates the method of trigonometric parallax, which is usually the most precise & accurate way to do it, in those cases where it can be done. It's a pretty straight forward process: You measure the angular position on the sky, for your target star, and then do it again 6 months later. The two points are separated by the diameter of Earth's orbit (a very well-known number).

Just as the distance between your own two eyes gives you depth perception, and a good estimate of distances, so do the two "eyes" separated by the diameter of Earth's orbit. Apply a little trigonometry to the observations, and out comes a distance. The technical challenge comes from the fact that the parallax angles for even the closest stars are really tiny, so measuring them requires a fanatical devotion to precision, in order that the unavoidable uncertainty in the measured angle will be significantly smaller than the angle itself. But we have that all figured out now, and we are really good at it. The Hipparcos & Gaia satellites have contributed enormously, measuring the parallax angles for millions of stars.

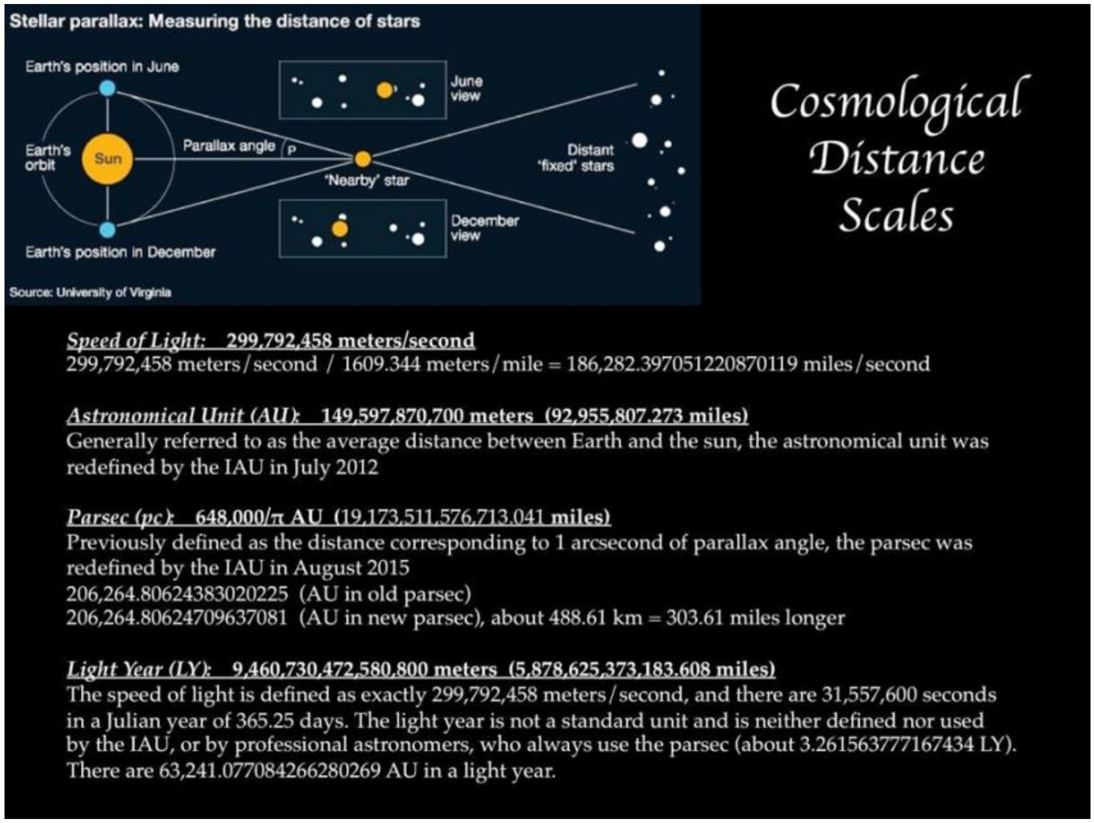
But Betelgeuse is a different kind of beast altogether, and is probably the most challenging star of them all, for parallax angle measurements. The reasons are that it is very big (about 0.040 arcseconds across), very bright (usually no dimmer than 10th brightest in the night sky), and variable in both size & brightness. All but a handful of stars observed in this way are

Club Events Calendar

Oct 30 Virtual General Meeting –
Alex McConahay "The Five C's of Astro-Imaging" and Ken Elchert "Lightsail"

Nov 7 Star Party -- Cottonwood Springs, Joshua Tree National Park
Nov 11 Virtual Board Meeting
Nov 20 Virtual General Meeting

Dec 5 Star Party -- Death Valley National Park
Dec 12 Christmas Party



A slide found in several of my talks, illustrating astronomical distance scales. The numerical precision is vastly greater than any observation can compete with. but since the fundamental definitions for the astronomical unit, the parsec, and the speed of light, are all exact numbers, I carried out the computations with the highest precision I could muster.

much smaller than the parallax angle, so the apparent parallax motion of the star, from "here" to "there" is significant.

But Betelgeuse is about 10 times bigger in diameter than is its parallax angle. So it shows no apparent parallax motion, like other stars, but rather a parallax "jiggle" of about one tenth of its own diameter. So if you want to find the true parallax angle, you have to find the true edge of the star in your particular telescope, with an uncertainty much smaller than the one-tenth diameter jiggle. It's looking a bit harder now, isn't it?

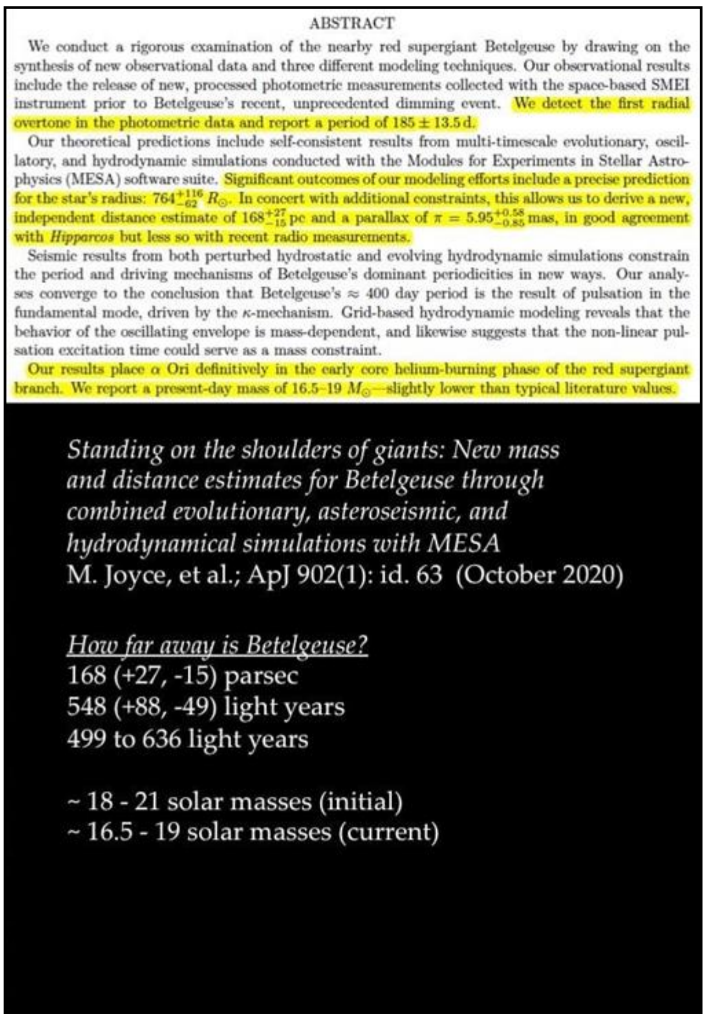
But Betelgeuse is variable in both size and shape, and it does not have a sharp edge in any image. It just gets dimmer as you approach the edge, and you have to figure out where the edge "most likely" is, in that ring of dimming around the star. The variability in size is not too bad, since you can find a most likely edge for each image, independently from any other image. But the variability in shape is another matter. Where exactly is the center of a not-round shape? And you don't want that center location to be biased by variations in brightness across the visible surface of the star.

And worse yet, the shape you see is not just the shape of the star. It's the shape of your star, plus deformations added by the telescope, and you need to remove those effects of the telescope before you try finding the edge of the star. That deformation added by the telescope is sensitive to the brightness of the star, and in the case of Betelgeuse, that can actually be a serious problem, if the imaging camera (which is part of the "telescope") is saturated, as it often will be for Betelgeuse.

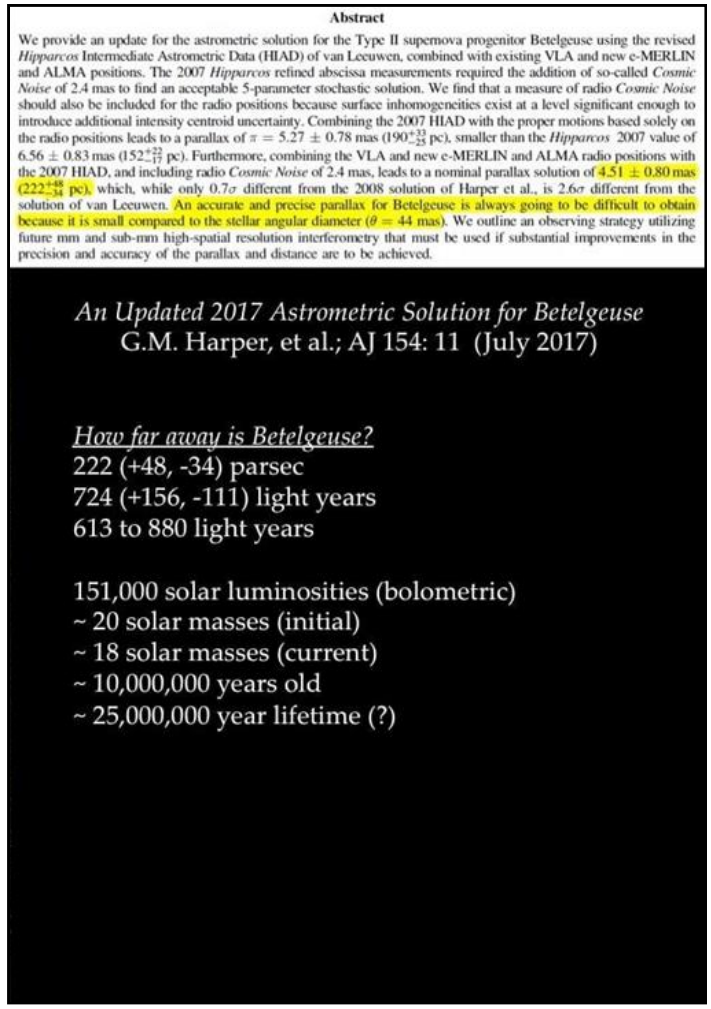
The point of all this is simply that measuring a parallax distance for Betelgeuse is fraught with uncertainty, and sensitive to necessary assumptions in reducing the data.

The 2nd image here is a slide from my talk on Betelgeuse, and documents the previously most recent attempt at deriving a distance for Betelgeuse, published in 2017 (Harper et al., 2017). In an effort to reduce the uncertainties, the authors of this study have combined data from multiple sources, to derive a more precise parallax angle, and therefore a more precise distance. as you can see, the data are still consistent with a distance anywhere from 613 to 880 light years, with 724 light years being "most probable".

The 3rd & 4th slides illustrate the new study, just published this month in the Astrophysical Journal. The 3rd slide shows that the new study is consistent with distances from 499 to 636 light years, which certainly extends to much shorter distances. However, note that in the range 613 to 636 light years, the new 2020 estimate and the older 2017 estimate are mutually consistent. So they could actually both be right, even if the probability seems low.



A newly created slide for my talk on Betelgeuse, illustrating the new latest & greatest determination of the distance to Betelgeuse (until something later & greater comes along).



A slide from my talk on Betelgeuse, illustrating what was the latest & greatest determination of the distance to Betelgeuse, as of 2017.

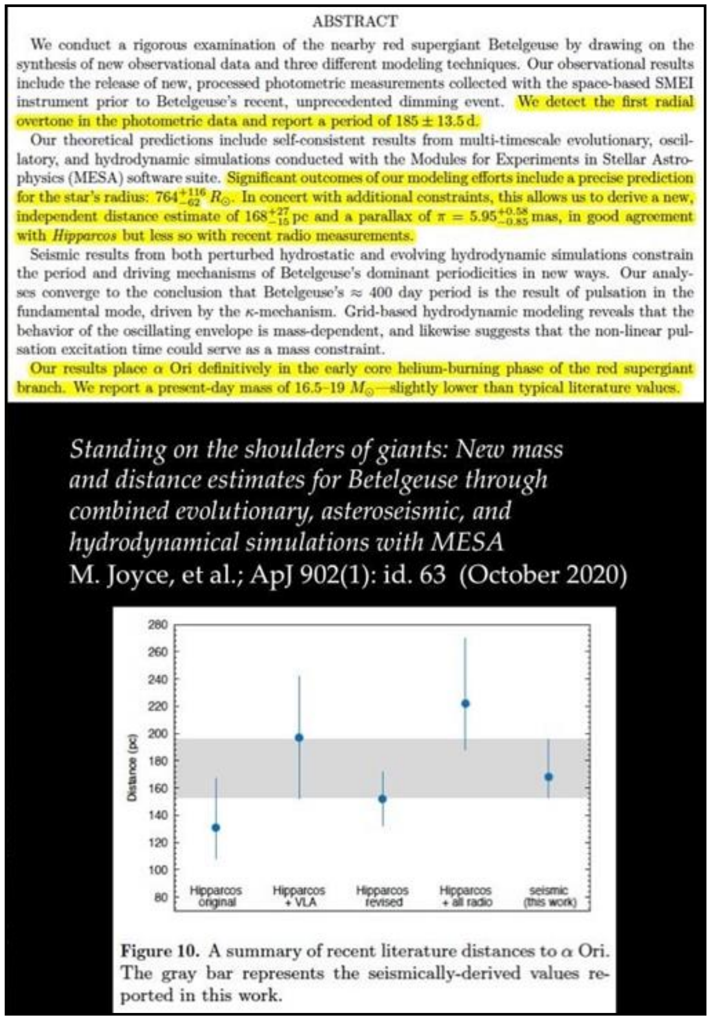
The really interesting thing about the new determination is that it is the first, so far as I know, to work the problem in reverse. Normally, one measures the parallax angle, and the angular diameter, and from them one derives a physical diameter. But in this new study, the authors use complex stellar structure models, including input from the relatively new field of asteroseismology, to compute the physical diameter of Betelgeuse. They then combine that with the observed angular diameter, and derive a distance (and therefore a parallax angle). It is backwards, and completely independent from previous research along these lines, as far as I can see.

The 4th slide includes a plot from Joyce, at al., 2020, which compared their distance estimate (the horizontal grey bar) with previous distance estimates, plotted as blue points, with uncertainty. The plot is not a function of time, but rather a function of the data sets used (methodology). Their results fall right in the middle of the distribution, which is an encouraging &

interesting result. Despite relying heavily on stellar physical models, they still produce a distance that is consistent with parallax angle observations. Two wildly different approaches produce essentially the same results. And since the new results lay pretty much in the middle of the distribution, maybe they make the most sense, until something better comes along. But that's not the same as insisting that they must be right.

"Don't panic! But Betelgeuse may be 25% closer to Earth than we previously thought" (16 October 2020)
Phil Plait ("The Bad Astronomer")

Tim Thompson


ABSTRACT

We conduct a rigorous examination of the nearby red supergiant Betelgeuse by drawing on the synthesis of new observational data and three different modeling techniques. Our observational results include the release of new, processed photometric measurements collected with the space-based SMEI instrument prior to Betelgeuse's recent, unprecedented dimming event. We detect the first radial overtone in the photometric data and report a period of 185 ± 13.5 d.

Our theoretical predictions include self-consistent results from multi-timescale evolutionary, oscillatory, and hydrodynamic simulations conducted with the Modules for Experiments in Stellar Astrophysics (MESA) software suite. Significant outcomes of our modeling efforts include a precise prediction for the star's radius: $764^{+116}_{-62}\ R_\odot$. In concert with additional constraints, this allows us to derive a new, independent distance estimate of 168^{+27}_{-15} pc and a parallax of $\pi = 5.95^{+0.58}_{-0.85}$ mas, in good agreement with *Hipparcos* but less so with recent radio measurements.

Seismic results from both perturbed hydrostatic and evolving hydrodynamic simulations constrain the period and driving mechanisms of Betelgeuse's dominant periodicities in new ways. Our analyses converge to the conclusion that Betelgeuse's ≈ 400 day period is the result of pulsation in the fundamental mode, driven by the κ-mechanism. Grid-based hydrodynamic modeling reveals that the behavior of the oscillating envelope is mass-dependent, and likewise suggests that the non-linear pulsation excitation time could serve as a mass constraint.

Our results place α Ori definitively in the early core helium-burning phase of the red supergiant branch. We report a present-day mass of 16.5–19 $M_\odot$—slightly lower than typical literature values.

A newly created slide for my talk on Betelgeuse, illustrating the new latest & greatest determination of the distance to Betelgeuse (until something later & greater comes along).

Announcements

Now would be a great time to get ahold of an issue of Sky & Telescope. On page 58 of their November 2020 issue, online or in print, is an article by David Nakamoto of the Los Angeles Astronomical Society who has spoken to PVAA in the past.

The article is titled "The Strange Case of Comet Biela" It vanished, then returned, then vanished again, only to possibly return anew. What gives? By David Nakamoto

Get yourself a copy to support a local amateur astronomer!

Claire Stover

A telescope made out of…

You're not going to believe the amazing detail and work that went into making this telescope…that you can eat!

https://www.youtube.com/watch?v=v4YkQqKbyKE

Larry Kawano

Historical Astronomy Division Prize

The Historical Astronomy Division (HAD) Prize Committee has awarded the 2021 Donald E. Osterbrock Book Prize for Historical Astronomy to Ileana Chinnici for her work Decoding the Stars: A Biography of Angelo Secchi, Jesuit and Scientist (Brill 2019).

This is the first full-length biography of Angelo Secchi in English and will become the definitive work on this important figure in early astrophysics. Secchi later became well known as part of the transition from classical positional astronomy to astrophysics. At the 25th anniversary of Secchi's death in 1896 George Ellery Hale praised his contributions "to the present widespread interest in Astro-physical research". Chinnici's work covers not only the research that Secchi is remembered for, but also the broader environment in which he worked. Based on extensive research in Italian and Vatican archives, it is richly illustrated with many color and black & white photographs.

Ileana Chinnici received a University degree in Physics from the University of Palermo, Italy. Her dissertation was "Pietro Tacchini (1838-1905): a first scientific biography". Since 2004 she has been a Research Astronomer at the INAF/Osservatorio Astronomico di Palermo, Italy, in charge of museum activities and specializing in the history of astrophysics.

The 2021 Osterbrock Book Prize will be presented to Dr. Chinnici at the virtual HAD Town Hall starting at 01:40pm on January 11, 2021, when she will give a presentation on this book. The HAD Town Hall will be held in conjunction with the virtual 237th AAS meeting, January 11-15 2021.

Pat Seitzer
HAD Prize Committee Chair

Committee Members: Brenda Corbin, Alan Hirshfeld, Ken Rumstay, Liba Taub
Book nominated for the prize by Jay Pasachoff and John Hearnshaw

Announcement forwarded to us by Bob Branch

2020 Antique Telescope Society Convention coming up in November

Thanks to Bob Branch for sharing with us this free virtual meeting coming up soon in mid-November. See the British Astronomical Association website for details. There will be presentations and observatory tours so should be some interesting activities for all.

https://britastro.org/node/24744

Book Sale!

We learned a lot about both Einstein and his Theory of General Relativity from Dr. Robert Piccioni during our September General Meeting.

If you would like to check out his publications and videos, they can be purchased online at his website. You can order anything out there but use this special link and the first page is the Astronomical Society Special Book Sale - you can order all the items on this page without paying a Shipping and Handling fee.

http://www.guidetothecosmos.com/Astro.html

NASA Night Sky Notes November 2020

This article is distributed by NASA Night Sky Network

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.gov to find local clubs, events, and more!

The International Space Station: 20 Continuously Crewed Years of Operation

David Prosper

Did you know that humans have been living in the International Space Station, uninterrupted, for twenty years? Ever since the first crew members docked with the International Space Station (ISS) in November 2000, more than 240 people have visited this outpost, representing 19 countries working together. They have been busy building, upgrading, and maintaining the space station - while simultaneously engaging in cutting-edge scientific research.

The first modules that would later make up the ISS were launched into orbit in 1998: the Russian Zarya launched via a Proton-K rocket, and the US-built Unity module launched about a week and a half later by the Space Shuttle Endeavour. Subsequent missions added vital elements and modules to the Space Station before it was ready to be inhabited. And at last, on November 2, 2000, Expedition-1 brought the first three permanent crew members to the station in a Russian Soyuz capsule: NASA astronaut William M. Shepherd and Russian cosmonauts Sergei Krikalev and Yuri Gidzenk. Since then, an entire generation has been born into a world where humans continually live and work in space! The pressurized space inside this modern engineering marvel is roughly equal to the volume of a Boeing 747, and is sometimes briefly shared by up to 13 individuals, though the average number of crew members is 6. The unique microgravity environment of the ISS means that long-term studies can be performed on the space station that can't be performed anywhere on Earth in many fields including space medicine, fluid dynamics, biology, meteorology and environmental monitoring, particle physics, and astrophysics. Of course, one of the biggest and longest experiments on board is research into the effects of microgravity on the human body itself, absolutely vital knowledge for future crewed exploration into deep space.

Stargazers have also enjoyed the presence of the ISS as it graces our skies with bright passes overhead. This space station is the largest object humans have yet put into orbit at 357 feet long, almost the length of an American football field (if end zones are included). The large solar arrays – 240 feet wide - reflect quite a bit of sunlight, at times making the ISS brighter than Venus to observers on the ground! Its morning and evening passes can be a treat for stargazers and can even be observed from brightly-lit cities. People all over the world can spot the ISS, and with an orbit only 90 minutes long, sometimes you can spot the station multiple times a night. You can find the next ISS pass near you and receive alerts at sites like NASA's Spot the Station website (spotthestation.nasa.gov) and stargazing and satellite tracking apps.

Hundreds of astronauts from all over the world have crewed the International Space Station over the last two decades, and their work has inspired countless people to look up and ponder humanity's presence and future in space. You can find out more about the International Space Station and how living and working on board this amazing outpost has helped prepare us to return to the Moon - and beyond! - at nasa.gov.

NASA Night Sky Notes November 2020

The ISS photobombs the Sun in this amazing image taken during the eclipse of August 21, 2017 from Banner, Wyoming. Photo credit: NASA/Joel Kowsky More info: bit.ly/eclipseiss

A complete view of the ISS as of October 4, 2018, taken from the Soyuz capsule of the departing crew of Expedition 56 from their Soyuz capsule. This structure was built by materials launched into orbit by 37 United States Space Shuttle missions and 5 Russian Proton and Soyuz rockets, and assembled and maintained by 230 spacewalks, with more to come! Credit: NASA/Roscosmos More info: bit.ly/issbasics