Forum Science and Space
Space/Astronomy Questions and Answers
Amateurs measuring parallax

Thread: Amateurs measuring parallax

2014-Feb-20, 11:17 PM #1

dtilque
Established Member

Join Date: May 2002
Location: My own private Nogero
Posts: 177

Amateurs measuring parallax

How easy would it be for amateur astronomers to measure parallax using off-the-shelf technology? What kind of precision could they get?

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2014-Feb-20, 11:51 PM #2

antoniseb
Administrator

Join Date: Jul 2005
Location: Massachusetts, USA
Posts: 21,685

If it were just based on diffraction limited viewing, and you wanted to do some finding-the-centroid work, you could probably do it with a very good 3-inch telescope. A 10-inch telescope could (in theory) get you 0.5 second resolution. You can buy 20+ inch telescopes on a largish amateur budget, which would get you (in theory) 0.25 second or better. Issues with your mount, clock-drive, weather, optics, etc will degrade that performance. There are several stars in the sky that 0.25 second resolution would be enough to show parallax.

Forming opinions as we speak

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2014-Feb-21, 12:15 AM #3

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

Recall that the first measurements of stellar parallax were made with small telescopes and the naked eye. Bessel's telescope had a diameter of 6.2 inches, though its special design helped him greatly to measure the parallax of 61 Cygni. Struve used a nine-inch refractor to measure the parallax of Vega. Henderson used a 4-inch mural circle to measure the parallax of alpha Centauri.

The issue isn't so much telescope size as method, patience, and skill.

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2014-Feb-21, 02:59 AM #4

Jeff Root
Order of Kilopi

Join Date: Dec 2004
Posts: 14,731

The question of this thread fits right in with something I've supposed for decades without ever trying to confirm before:

Until the advent of CCDs and images from HST and other high-resolution telescopes became available online, I'd guess that far less than a thousand people -- maybe even less than a hundred -- had ever made an actual measurement of stellar parallax. Does that seem right to you?

If my guess was right, I think it means that using the parsec as the standard unit of astronomical distances was an especially bad choice. It is a unit that almost nobody has ever calculated from measurements they made, and nobody has ever made a direct measurement of distance in parsecs (it isn't possible). The measurement which can be used to calculate a distance in parsecs only works for observers on one particular planet, when observing the stars closest to that planet.

Now that tools and images are available to make measurements easier, I suppose there might be more people measuring stellar distances, so the parsec might no longer be quite as inappropriate as it was a few years ago.

-- Jeff, in Minneapolis

http://www.FreeMars.org/jeff/

"I find astronomy very interesting, but I wouldn't if I thought we were just going to sit here and look." -- "Van Rijn"

"The other planets? Well, they just happen to be there, but the point of rockets is to explore them!" -- Kai Yeves

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2014-Feb-21, 03:17 AM #5

ngc3314
Established Member

Join Date: Mar 2004
Posts: 3,065

Dennis Di Cicco did a nice series of CCD astrometric measurements for Barnard's Star using 11-16-inch telescopes, and got a very solid measurement of its parallax. One place showing his plot is here.

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2014-Feb-21, 05:22 AM #6

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

> Originally Posted by **Jeff Root**
> *Until the advent of CCDs and images from HST and other high-resolution telescopes became available online, I'd guess that far less than a thousand people -- maybe even less than a hundred -- had ever made an actual measurement of stellar parallax. Does that seem right to you?*

Actually, I'd wager that the opposite is true: yes, before CCDs were invented, probably fewer than 1,000 people had ever measured a parallax themselves. Since the advent of CCDs, but, more importantly, computers and measuring engines, I'd guess that even _fewer_ people have measured a stellar parallax themselves. These days, thousands of parallax measurements are made by pipelines of software, fed images which have been taken by machines and reduced automatically.

> *If my guess was right, I think it means that using the parsec as the standard unit of astronomical distances was an especially bad choice.*

Hmmm. I don't see how any unit of distance of stellar scale is better or worse than any other, really.
But different squids for different kids.

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2014-Feb-21, 03:04 PM #7

Jeff Root
Order of Kilopi

Join Date: Dec 2004
Posts: 14,731

Setting up your machine to measure something counts for me as measuring it yourself, in this case.

A parsec is a unit that is completely disconnected from anything that is actually observed. It can only be calculated from what can be observed. If virtually no-one makes those observations, it is doubly disconnected.

While the light-year and related units are also based on Earth-centric base units (the year and the second), they are intuitively obvious in application: light travels a certain distance in a given time. And it applies to any distance in any location, not just to the stars nearest Earth.

Parsecs are perfect for recording distances of the nearest stars meaured using parallax from Earth. For any other purpose, they have no advantage over other units which are far more readily understood.

How easy is it to explain what a parsec is? How easy is it to explain what a light-second is?

-- Jeff, in Minneapolis

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Last edited by Jeff Root; 2014-Feb-21 at 03:11 PM.

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http://www.FreeMars.org/jeff/

"I find astronomy very interesting, but I wouldn't if I thought we were just going to sit here and look." -- "Van Rijn"

"The other planets? Well, they just happen to be there, but the point of rockets is to explore them!" -- Kai Yeves

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2014-Feb-21, 03:46 PM #8

ngc3314
Established Member

Join Date: Mar 2004
Posts: 3,065

I take both points. Any unit is arbitrary if tied to the Earth. Parsecs, light-years, SI lengths. Parsecs seem to have won out in the research literature, although light-years may have appeared first and do have the advantage that we intuitively grasp the scale difference between a light-second and a light-year. (This is why I favor light-years in my nonmathematical intro classes).

OTOH, a light-year is certainly no more directly connected to what we actually observe than is a parsec, once we get beyond the limits of ranging within the Solar System.

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2014-Feb-21, 04:59 PM #9

Join Date: Dec 2004

Posts: 14,731

Jeff Root
Order of Kilopi

> Originally Posted by **ngc3314**
> *OTOH, a light-year is certainly no more directly connected to what we actually observe than is a parsec, once we get beyond the limits of ranging within the Solar System.*

It **is** more directly connected: We observe an object which is x light-time units away as it was x time units ago. There is no comparable relationship for parsecs except for the amount of annual wiggling of nearby stars.

-- Jeff, in Minneapolis

---

http://www.FreeMars.org/jeff/

"I find astronomy very interesting, but I wouldn't if I thought we were just going to sit here and look." -- "Van Rijn"

"The other planets? Well, they just happen to be there, but the point of rockets is to explore them!" -- Kai Yeves

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2014-Feb-21, 05:40 PM #10

ngc3314
Established Member

Join Date: Mar 2004
Posts: 3,065

> Originally Posted by **Jeff Root**
> *A parsec is a unit that is completely disconnected from anything that is actually observed.*

More directly connected to something interesting, but beyond the limits of radar ranging and things like the time delay of orbital phenomena of planetary satellites, we don't directly *observe* the delay of seeing distant objects. (I don't really disagree with you, but your post brought up direct observation, which I see as a bit of a red herring compared to intuitive grasp of orders of magnitude).

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2014-Feb-21, 08:18 PM #11

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

> Originally Posted by **Jeff Root**

> *A parsec is a unit that is completely disconnected from anything that is actually observed.*

So, the astronomers who measure the positions of stars and other objects over the course of several years, and who see some nearby objects moving relative to more distant objects, like this
(taken from the VERA collaboration -- see http://lanl.arxiv.org/abs/0709.0820)

vera_panel.gif

or this (taken from the Hipparcos mission)

vega_motion.gif

aren't observing anything connected to parallax? Really?

Gosh, what are they observing?

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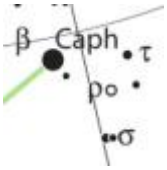
2014-Feb-21, 09:23 PM #12



mapguy
Member

Join Date: Dec 2011
Posts: 94

> Originally Posted by **StupendousMan**
> *Recall that the first measurements of stellar parallax were made with small telescopes and the naked eye. Bessel's telescope had a diameter of 6.2 inches, though its special design helped him greatly to measure the parallax of 61 Cygni. Struve used a nine-inch refractor to measure the parallax of Vega. Henderson used a 4-inch mural circle to measure the parallax of alpha Centauri. The issue isn't so much telescope size as method, patience, and skill.*

According to the Wiki "Galaxy" article, already by around 500 A.D. we knew the Milky Way had no parallax. Is that true, and if so, how could we have known that without telescopes?

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2014-Feb-21, 09:39 PM #13

glappkaeft
Established Member

Join Date: Jan 2008
Posts: 611

> Originally Posted by **Wikipedia article**
> *The Neoplatonist philosopher Olympiodorus the Younger (c. 495–570 AD) was scientifically critical of this view, arguing that if the Milky Way were sublunary (situated between the Earth and the Moon) it should appear different at different times and places on the Earth, and that it should have parallax, which it does not.*

This amount of parallax does not need a telescope to measure.

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2014-Feb-21, 10:11 PM #14

Jeff Root
Order of Kilopi

Join Date: Dec 2004
Posts: 14,731

> Originally Posted by **Jeff Root**
> *A parsec is a unit that is completely disconnected from anything that is actually observed.*

Put that sentence in the context of the rest of the paragraph it was in.

-- Jeff, in Minneapolis

---

http://www.FreeMars.org/jeff/

"I find astronomy very interesting, but I wouldn't if I thought we were just going to sit here and look." -- "Van Rijn"

"The other planets? Well, they just happen to be there, but the point of rockets is to explore them!" -- Kai Yeves

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2014-Feb-22, 02:17 AM #15

Hornblower
Order of Kilopi

Join Date: Mar 2007
Location: Falls Church, VA (near Washington, DC)
Posts: 7,850

> Originally Posted by **Jeff Root**
> *It **is** more directly connected: We observe an object which is x light-time units away as it was x time units ago. There is no comparable relationship for parsecs except for the amount of annual wiggling of nearby stars.*
>
> *-- Jeff, in Minneapolis*

The light-year is a function of the speed of light and an arbitrarily chosen unit of time. The parsec is a function of the longest usable baseline and an arbitrarily chosen unit of angular measure. I would say it is a tossup in arbitrariness.

The parsec is directly related to what we actually observe, which is the wiggle of the star as we go around our orbit. We do not measure the transit time of the light from the star. Thus I would say that the parsec is completely connected with what actually is observed.

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2014-Feb-22, 02:32 AM #16

Jeff Root
Order of Kilopi

Join Date: Dec 2004
Posts: 14,731

Nobody ever measures the wiggle of a star. What is measured is the offset of the position of a star in two different images. Then a set of calculations are applied which factor in various angles and distances and correctons for all sorts of motions and variables in the viewing environment. That is repeated several times, and the average value of the result is the distance in parsecs.

The arbitrarily chosen unit of time is used for all kinds of things by everyone on Earth, constantly, so it, at least, is very familiar. The part that is not so familiar is the speed of light. But if you have made an intercontinental phone call that goes through a communications satellite in geosynchronous orbit, you'll have *some* familiarity with it.

-- Jeff, in Minneapolis

---

http://www.FreeMars.org/jeff/

"I find astronomy very interesting, but I wouldn't if I thought we were just going to sit here and look." -- "Van Rijn"

"The other planets? Well, they just happen to be there, but the point of rockets is to explore them!" -- Kai Yeves

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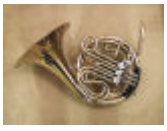
2014-Feb-23, 12:17 AM #17



Hornblower
Order of Kilopi

Join Date: Mar 2007
Location: Falls Church, VA (near Washington, DC)
Posts: 7,850

> Originally Posted by **Jeff Root**
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> *Nobody ever measures the wiggle of a star. What is measured is the offset of the position of a star in two different images. Then a set of calculations are applied which factor in various angles and distances and correctons for all sorts of motions and variables in the viewing environment. That is repeated several times, and the average value of the result is the distance in parsecs.*
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>
> *-- Jeff, in Minneapolis*

When I said "wiggle", I was referring to the annual sinusoidal parallax component of the motions to which you correctly referred. Once again, we are actually observing variations in the angular

positions of the stars, and the parsec is defined in terms of this variation along with the length of our base line. I stand by my previous statement.

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2014-Feb-23, 04:18 PM #18

wd40
Established Member

Join Date: Mar 2009
Posts: 1,606

Are amateurs capable of detecting the negative parallaxes which make up 25% of the Tycho Main Catalogue?

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2014-Feb-23, 06:23 PM #19

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

Anyone -- anyone --- who tries to measure the parallaxes of very distant stars will end up with lots and lots of negative values. Noisy measurements of a quantity close to zero, plus a calculation involving reciprocals = (false) negative values.

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2014-Feb-23, 07:09 PM #20

wd40
Established Member

Join Date: Mar 2009
Posts: 1,606

> Originally Posted by **StupendousMan**
> *= (false) negative values.*

If a negative parallax value turned out to be real, what would that imply about the star?

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2014-Feb-23, 07:25 PM #21

glappkaeft
Established Member

Join Date: Jan 2008
Posts: 611

> Originally Posted by **wd40**
> *If a negative parallax value turned out to be real, what would that imply about the star?*

It can't be negative by definition.

Reply With Quote

2014-Feb-23, 09:48 PM #22

wd40
Established Member

Join Date: Mar 2009
Posts: 1,606

Could it be said in theory that negative parallax stars are further away than the majority of stars that show no parallax?

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2014-Feb-23, 10:26 PM #23

Hornblower
Order of Kilopi

Join Date: Mar 2007
Location: Falls Church, VA (near Washington, DC)
Posts: 7,850

> Originally Posted by **wd40**
> *Could it be said in theory that negative parallax stars are further away than the majority of stars that show no parallax?*

I would say that they are farther away than reference stars that have what should be observable parallax that somehow was not recognized. I think it would require a statistical fluke in the distribution of the stars in a particular field of view.

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2014-Feb-23, 11:40 PM #24

Hornblower
Order of Kilopi

Join Date: Mar 2007
Location: Falls Church, VA (near Washington, DC)
Posts: 7,850

Addendum: Let me elaborate a bit. On any astrometric photograph many of the background stars will have small amounts of parallax that is barely detectable with the measuring instruments, and failure to allow for it will cause the parallax of a nearby star to be somewhat underestimated. Most photos will have a typical average amount that has been estimated statistically by the observers. If a field has a sparse, unrecognized cluster at some intermediate distance, that cluster might bias the statistically assigned residual parallax. A truly distant supergiant seen through this anomalous field would then appear to have a negative parallax. If we could somehow get truly distant supergiants, or better yet quasars, in every sample the problem would go away.

I am no expert, but I think I am on the right track here.

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2014-Feb-24, 01:12 AM #25

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

It's actually quite simple: suppose that you measure the positions of 10 stars in a field, and each measurement has an uncertainty of +/- 0.1 arcseconds. Suppose that all 10 stars are so far away (say, 10000 pc) that their actual parallax (of order 0.0001 arcsec) is swamped by the uncertainty in the measurements.

You use 9 of the stars to define a reference frame. Okay. Then, you measure the motion of the tenth star relative to that reference frame.
All you are really doing is "measuring" the noise. Since the noise can make the star appear to move any random direction, there's a fifty-ish
percent chance that the star will appear to move in the direction opposite to that which parallax would cause it move. Bing! An apparent
negative parallax.

Reply With Quote

2014-Feb-24, 01:55 AM #26

wd40
Established Member

Join Date: Mar 2009
Posts: 1,606

Over 1 million objects are listed in the Tycho Main Catalogue, and they state: "The trigonometric parallax is expressed in units of milliarcsec. The estimated parallax is given for every star, even if it appears to be insignificant or negative (which may arise when the true parallax is smaller than its error)."

25% have negative parallax, 29% positive parallax and 46% assumed zero parallax.

Tests were done to see if the stars moving across the instrument slit were directionally different in the northern celestial hemisphere to what they were in the southern celestial hemisphere. Of the non-zero-parallax stars in the northern celestial hemisphere, 45% of them had a negative parallax, and in the southern celestial hemisphere, 46% of non-zero objects had a negative parallax.

Could this very symmetrical distribution be a naturally occurring phenomenon?

Last edited by wd40; 2014-Feb-24 at 01:59 AM.

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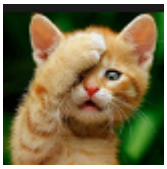
2014-Feb-24, 04:18 AM #27



pzkpfw
Order of Kilopi

Join Date: Jan 2005
Location: Anzakistan
Posts: 10,710

My underline:

> Originally Posted by **wd40**
> *Over 1 million objects are listed in the Tycho Main Catalogue, and they state: "The trigonometric parallax is expressed in units of milliarcsec. The estimated parallax is given for every star, even if it appears to be insignificant or negative (which may arise when the true parallax is smaller than its error)."*

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>
> *Could this very symmetrical distribution be a naturally occurring phenomenon?*

I don't understand why it *wouldn't* be "natural". Why would there be fewer/lower errors North than South or vice versa?

What is it you think is going on?

Measure once, cut twice. Practice makes perfect.

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2014-Feb-24, 12:42 PM #28

wd40
Established Member

Join Date: Mar 2009
Posts: 1,606

Negative parallax is generally viewed as being impossible or incompatible eg unlike the Tycho Catalogue, in the Hipparcos Catalogue it has been artificially weighted about the zero value by restricting the negative range, negative parallaxes being dismissed as statistical errors.

63 Ophiuci:
"Uncertain negative parallax measurements of –0.77 ± 0.40 mas suggest that this extremely luminous star may be located about 4000 light-years away."

What if its negative parallax was found to be certain rather than uncertain?

Last edited by wd40; 2014-Feb-24 at 12:46 PM.

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2014-Feb-24, 12:54 PM #29

StupendousMan
Established Member

Join Date: Sep 2006
Posts: 1,740

Your question carries about as much meaning as someone asking, "2+2 = 4 most of the time, sure, but what would happen if 2 + 2 = -4?"

Reply With Quote

2014-Feb-24, 01:48 PM #30

Join Date: Mar 2007
Location: Falls Church, VA (near Washington, DC)
Posts: 7,850

Hornblower
Order of Kilopi

> Originally Posted by **wd40**
>
> *Negative parallax is generally viewed as being impossible or incompatible eg unlike the Tycho Catalogue, in the Hipparcos Catalogue it has been artificially weighted about the zero value by restricting the negative range, negative parallaxes being dismissed as statistical errors.*
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> *63 Ophiuci:*
> *"Uncertain negative parallax measurements of –0.77 ± 0.40 mas suggest that this extremely luminous star may be located about 4000 light-years away."*
>
> *What if its negative parallax was found to be certain rather than uncertain?*

Please tell us, in appropriate geometric detail, what you mean by "certain negative parallax".

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Page 1 of 2 1 2 Last

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