

Tuesday, 23.06.2020

Time UTC	Time CEST	Speaker	Subject	
12:50 - 13:00	14:50 - 15:00		Announcements	
13:00 - 13:25	15:00 - 15:25	Lennart Lindegren	Gaia astrometry and its contributions to the distance scale	<a href="#">Q&amp;A</a>
13:25 - 13:50	15:25 - 15:50	Grzegorz Pietrzynski	Absolute distances to standard candles	<a href="#">Q&amp;A</a>
13:50 - 14:15	15:50 - 16:15	Caroline Huang	The Mira distance ladder	<a href="#">Q&amp;A</a>
14:15 - 14:40	16:15 - 16:40	Bruno Leibundgut	Supernovae as standardizable candles	<a href="#">Q&amp;A</a>
14:40 - 15:10	16:40 - 17:10	Panelists & speakers	Discussion	<a href="#">Q&amp;A</a>
Panelists: P. Kervella, D. Scolnic, R. de Grijs, M. Rigault, M. Rejkuba				
<a href="#">Link to YouTube Video</a>				

## 05 Lennart Lindegren - Gaia

 There are already 6 questions with 7 upvotes. Here are the most popular ones:

**Where you compare Gaia parallaxes (yellow points) with quasar parallaxes (blue line), could you give an indication of the spread of the quasar parallaxes?**

by Anonymous | 2 upvotes

- **Lennart Lindegren** 2:51 PM

Answers to some of the remaining questions after my talk yesterday: Anonymous asked: "Where you compare Gaia parallaxes (yellow points) with quasar parallaxes (blue line), could you give an indication of the spread of the quasar parallaxes?"

A: In DR2 (which was shown on the slides) the RMS spread around the median increases rapidly with magnitude (G). It is about 60 microarcsec (muas) for  $G < 15$ , 100 muas at  $G = 16$ , 400 muas at  $G = 19$ , and 1 mas at the faint end. For EDR3 the spread is typically a factor 0.7 smaller.

**What is Parallax zero point? Is it an error related to the angle variation between the two telescopes?**

by Yan | 2 upvotes

- **Lennart Lindegren** 2:51 PM

@Yan asked: "What is Parallax zero point? Is it an error related to the angle variation between the two telescopes?"

A: Yes, a periodic variation of the basic angle could cause a shift of the parallax zero point. But that would be the same for all stars, independent of their magnitude and position. Since, empirically, the zero point is not the same everywhere, there must be other instrumental effects contributing to the zero point.

### **In tests where we compare parallaxes for stars with $G < 6$ in open clusters to fainter members we find that the offset shows**

by Tom Shanks (Durham) | 1 upvote

- **Lennart Lindegren** 2:51 PM

@Tom Shanks (Durham) commented: "In tests where we compare parallaxes for stars with  $G < 6$  in open clusters to fainter members we find that the offset shows little magnitude dependence."

A: Thanks. I'm actually surprised since  $G < 6$  gives strong saturation effects so I would expect more bias.

### **Will the Gaia team take the lead in characterizing the zero point offset (beyond using quasars, for example) or will this be left to the community?**

by Anonymous | 1 upvote

- **Lennart Lindegren** 2:51 PM

Anonymous asked: "Will the Gaia team take the lead in characterizing the zero point offset (beyond using quasars, for example) or will this be left to the community?"

A: Yes, there will be an attempt to characterize the offset in EDR3 over a much wider range of parameter space than covered by the quasars. But this is an area where I expect the community will be able to contribute a lot by finding novel methods to address the problem.

### **How will the Gaia extinction map compare with the current favourite, the Schlegel et al. map?**

by Anonymous | 1 upvote

- **Lennart Lindegren** 2:51 PM

Anonymous asked: "How will the Gaia extinction map compare with the current favourite, the Schlegel et al. map?"

A: I am no expert on this, but I assume it will have better depth resolution and extend further out from the sun.

Latest question

### **What is the current status of zero point calibration of stars in the distance ladder (RRL, Cep, Miras...)**

by *Anonymous* | No upvotes

- **Lennart Lindegren** 2:51 PM

Anonymous asked: "What is the current status of zero point calibration of stars in the distance ladder (RRL, Cep, Miras...)"

A: I think this question is addressed in several other talks and may be better answered by the experts in those areas.

### **06 Grzegorz Pietrzynski - Absolute distances to standard candles**

 There are already 6 questions with 24 upvotes. Here are the most popular ones:

**How many eclipsing binaries do you have in your sample and how many would you need to determine geometrical correction from your own data?**

by *Marina Rejkuba* | 6 upvotes

**How do you deal with radiative transfer assumptions and the corresponding limb darkening of the stellar surface emission?**

by *Anonymous* | 5 upvotes

**Can you say something about the effect of (differential) reddening on TRGB stars in the LMC and their relative position to the LMC's bar?**

by *Richard Anderson (ESO)* | 5 upvotes

**What is the helium abundance assumption when studying the effect of metallicity variation?**

by *Anonymous* | 4 upvotes

**Is foreground reddening from Schlegel valid for LMC when LMC itself glows in FIR?**

by *Anonymous* | 2 upvotes

Latest question

**What do you think the discrepancy on the theoretical colors might come from?**

by Anonymous | 2 upvotes

**07 Caroline Huang - The Mira distance ladder**

 There are already 9 questions with 15 upvotes. Here are the most popular ones:

**Thanks to their IR brightness, Mira stars should be good targets for observations in distant galaxies using the JWST. Will circumstellar dust be a problem ?**

by Pierre Kervella | 4 upvotes

- **Caroline Huang** Jun 23rd at 5:24 PM

Hi @Pierre Kervella--thanks for your question about circumstellar dust! The longer wavelengths that JWST has access to will help with issues from circumstellar dust. Figure 2 from <https://academic.oup.com/mnras/article/412/4/2345/1019075> shows how the clump of C-rich stars (which have more dust and don't follow a PLR at shorter wavelength) begins to follow a tight linear PLR at 3.6 micron and can even be brighter than O-rich Miras at the same wavelength. So I think for JWST it will be important to understand how to calibrate these C-rich and long-period variables, which is part of the work Wenlong Yuan is leading with follow up observations of HST SN Ia-Mira host galaxies.

- **Pierre Kervella** 15 days ago

Thank you @Caroline Huang.

**Which systematic uncertainties do you think it will be easiest to reduce in future work as statistics increase? Which will be most difficult?**

by Anonymous | 3 upvotes

- **Caroline Huang** 5:51 PM

*Anonymous question 1 on systematic uncertainties--I think a lot of what would be more or less difficult depends on what data we can obtain. Right now, increasing the number of Miras measured by HST will help us decrease the uncertainty on the slope. The systematic uncertainty in the color term (from transforming ground-based JHK to HST bandpasses) would also decrease if we are able to get objects in common from HST*

and ground-based filters. This might be possible with a few nearby galaxies (NGC 4258 and M31). A lot of work has also been done recently by Martha Boyer's group in local dwarf galaxies across a range of metallicities to establish this effect (in the DUSTINGS project). Patricia Whitelock has also looked into Mira PLRs in various environments (particularly in Whitelock et al. 2008). I think reddening is a bit more difficult to tackle, but we have also been fairly conservative of our estimate of the systematic from reddening there since we haven't yet seen a spatial trend in our data. But as mentioned in my previous response to Pierre Kervella, this will also be less of an issue if we continue to explore Miras at longer wavelengths.

### **Why do you have lower limit on Period (240 days) for the Miras sample used for distance determinations?**

by Marina Rejkuba | 3 upvotes

- **Caroline Huang** 5:30 PM

@Marina Rejkuba That is a great question and the answer is that we were concerned about the shortest period objects being incomplete in our sample due to the intrinsic width of the Mira PLR. We used the HST ETC to obtain an initial guess for at what period we might start to lose the faintest objects (about 200 days). Then we empirically determined the zeropoint of the PLR in small bins of period to see at what period we no longer see a trend in the zeropoint as a function of period--at this point we considered the PLR complete (at 240 days). We then did simulations to verify this result.

- **Marina Rejkuba** 6:02 PM

Thanks @Caroline Huang for your detailed answers to all questions and the nice presentation today!

- **Caroline Huang** 16 days ago

Thank you!

### **You argued that Miras could be identified in the NIR, yet the OGLE sources are optical. Would you get more precise distances using the VMC data which is deeper?**

by Anonymous | 2 upvotes

- **Caroline Huang** 5:51 PM

Anonymous question 2 on OGLE sources--Yes, the OGLE sources are optical, and since the LMC is nearby its Miras were bright enough to be observed in the optical. I think with deeper VMC data we could probably get more precise distances. Right now, the OGLE optical light curves are used to get periods and amplitudes. The OGLE sources were then cross-matched with JHK data from 2MASS, and Yuan et al also created templates for the JHK observations using the optical data to correct to mean magnitude. Having more time-series NIR observations would definitely help with this.

### **Is there a direct comparison between TRGB and Mira distances in NGC1559?**

*by Richard Anderson (ESO) | 2 upvotes*

- [Caroline Huang](#) 5:51 PM

*I don't think there are TRGB distances to NGC 1559 yet. However, at ~19 Mpc it seems like it should be reachable with TRGB.*

Latest question

### **When you have so few Mira distances, and only one SN host to date, how do you get uncertainties in $H_0$ that are almost comparable to Cepheids and TRGB?**

*by Anonymous | No upvotes*

- [Caroline Huang](#) 5:51 PM

Last anonymous question--Our uncertainties on the  $H_0$  measured by Miras are not comparable to the Cepheid uncertainties--we have an uncertainty in  $H_0$  of 5.5% which is much larger than either Cepheid (currently sub 2%) and TRGB (I think ~2.7%). So our uncertainties are much larger, as expected. Perhaps I have misunderstood this question? It's also worthwhile to keep in mind that both anchors we used have themselves distances precise to ~1%. I also wanted to clarify that while we have only one SN Ia calibrator, but the sample of SNe Ia in the Hubble flow is the same as that used in the Cepheid distance ladder.

## **08 Bruno Leibundgut - Supernovae**

 There are already 13 questions with 33 upvotes. Here are the most popular ones:

### **Why SNIa is a standard candle when we still don't know the physical model behind it (single and double degenerated model)?**

*by Anonymous | 7 upvotes*

- **Bruno Leibundgut** 5:43 PM

*A: It is correct that we do not understand the explosions from first principles, but the quality of SNe Ia as distance indicators is demonstrated best by the small scatter around the expansion line in the Hubble diagram. The SNe Ia show the smallest scatter of all cosmological distance indicators.*

### **Given the rich datasets, can machine learning address the complexity in SNe classifications and assist in finding the 'right' SNe for precision H0 estimation?**

*by Matthew Colless | 5 upvotes*

- **Bruno Leibundgut** 5:43 PM

A: Several attempts have been made to use machine learning for classifications. Most of the discussions among SN samples are combining samples from different sources, which often introduce systematic differences. It might be difficult to define a good learning set.

### **How can the SHOES Cepheid calibration be transferred to, e.g., the Pantheon sample?**

*by Lloyd Knox | 5 upvotes*

- **Bruno Leibundgut** 5:43 PM

A: This question was already answered by Dan Scolnic. In a recent paper Dhawan et al. (2020, ApJ 894, 54, <https://ui.adsabs.harvard.edu/abs/2020ApJ...894...54D/abstract>) have done this.

### **Are the alpha/beta nuisance parameters simultaneously fit, when fitting the data?**

*by Valeria Pettorino | 4 upvotes*

- **Bruno Leibundgut** 5:43 PM

A: Yes, all nuisance parameters are fit simultaneously with the cosmology.

### **Distant SN are observed in the rest-frame UV, for which we have few -if any- counterparts at low redshift. How much does this contribute to the**

## **systematics ?**

by Anonymous | 4 upvotes

- **Bruno Leibundgut** 5:43 PM

A: For  $H_0$  not this effect is small as the redshifts are small and the K-corrections are calculated routinely. The problem can be more serious for high-redshift supernovae, but many of them are measured in red or near-infrared filters to be close to the optical B and V filters, where there are large data samples.

Latest question

## **Why are SNe II promising as distance indicators even though the intrinsic scatter is almost twice that of SNe Ia?**

by Anonymous | 3 upvotes

- **Bruno Leibundgut** 5:43 PM

A: The SCM method employs a correction for expansion velocity of the explosion and correlates it with the luminosity during the light curve plateau phase. This works surprisingly well and has a rough physical foundation: a more energetic explosion will emit more light (see the latest analysis by de Jaeger et al. (2017, ApJ 835, 166; <https://ui.adsabs.harvard.edu/abs/2017ApJ...835..166D/abstract>). Type II supernovae are less luminous and have not been observed to the same high redshifts as Type Ia supernovae, but they are promising for an independent determination of the Hubble constant.

**Bruno Leibundgut** 5:43 PM

## **Is host galaxy stellar mass the best additional correction parameter for SNIa? Could using something else help reduce the $H_0$ tension?**

A: I am not aware of other parameters discussed, which could influence the distance measurements.

## **Q Levon Pogonian**

## **Is it known to what extent removing the 3-sigma outliers affects the resultant uncertainty in $H_0$ ?**

A: Not really. Obviously, the uncertainty on the measured parameters decreases. It could be a source of systematics.

**Q**

**It has been suggested there may be two populations of 'prompt' and 'delayed' SN1A. Is there evidence for this?**

A: Yes, there is evidence for different channels (e.g. Maoz, Mannucci & Nelemans, 2014, ARA&A 52, 107; <https://ui.adsabs.harvard.edu/abs/2014ARA%26A..52..107M/abstract>).

**Q Lloyd Knox**

**If H0 discrepancy is caused by something off in our understanding of supernovae -- first of all, do you see that as a possibility -- second, what might that be?**

A: As I said in my talk, I do not think that the supernovae are the source of the discrepancy of H0. It is the calibration of their absolute luminosity, which is provided by Cepheids, TRGB, inverse distance ladder, etc.

**Q**

**Some recent analyses for H0 use photographic SN Ia like 80N,81D. Do such data likely have same dispersion?**

A: The SH0ES analysis only uses modern data and does not include any photometry based on photographic plates.

**Q**

**There have been papers showing you can calibrate SNe Ia and H0 directly with strong lensing at high-z. Does that give another calibration?**

A: So far, only one strongly lensed SN Ia has been observed. The time delay was too short to be measurable. Future surveys will provide such data. It will have the same systematics as the quasar lens delay measurements. As was pointed during the conference a stochastic noise is added through microlensing. It will have to be seen how big that effect will be.

**Q**

**What uncertainty on the explosion date would be required for each of the 30 Type II's in the adH0cc sample?**

A: We are aiming at uncertainties below 3 to 5 days. Modern surveys have high cadences and pre-explosion observations within a few days of the explosions. The objects we use are specifically chosen to have a pre-explosion observation very close to the discovery date.

## Discussion Panel 2

 There are already 4 questions with 12 upvotes. Here are the most popular ones:

**Could the inhomogeneous distribution of SNIa in the sky bias the H0 determination in the case of a local expansion anisotropy or a biased bulk flow treatment?**

*by David Aguilera | 5 upvotes*

**What are the two most important issues to solve for improving the precision and accuracy of**

*by Richard Anderson (ESO) | 3 upvotes*

**How well can the SHOES Cepheid calibration be transferred to, e.g., the Pantheon sample?**

*by Lloyd Knox | 2 upvotes*

**Relaying for Tom Shanks: On eclipsing binaries, is there a possible issue with crowding in the LMC?**

*by Richard Anderson (ESO) | 2 upvotes*

- **Grzegorz Pietrzynski** 16 days ago

I do not think so. We obtained HST UBVI photometry and we checked the crowding. In the case of EBs we can also model the third light. We did an experiment and add 1% additional light and ... it was not possible to obtain a self consistent model.

**Tom Shanks** 7:29 PM

Jeremy Mould: Pierce & Tully 1992 ApJ 387:47 had 15 TF calibrators - see analysis by PD Allen +TS 2004 MN **347**, 1011 after KP Cepheid results out to Virgo cluster appeared. So TF hardly "got out the car park" before it needed recalibrating!

**Dragan Huterer** Jun 23rd at 9:48 PM

Let me chance a rookie question: could someone recommend a good basic (intro grad-level I guess) reading for concepts having to do with ether GAIA-type science (parallax fitting, "astrometric solution", zeropoint offset etc etc), and/or local distance ladder beyond the most basic (so MIRAs, water maser, DEB, that kind of thing)?

- **Rachael Beaton** 15 days ago

hmm. I'm partial to: <https://www.springer.com/gp/book/9789402416305>

The individual chapters are on ArXiv -- but that is the central repository for the end-to-end work.

Actually, hmm, that's not the link I thought it was.

huzzah,

here: [https://link.springer.com/journal/11214/topicalCollection/AC\\_de7f789e38e0f8c6f5a133374c67b0ea/page/1](https://link.springer.com/journal/11214/topicalCollection/AC_de7f789e38e0f8c6f5a133374c67b0ea/page/1)

- **Dragan Huterer** 15 days ago

Thank you @Rachael Beaton, that looks like exactly what I was asking about!

- **Rachael Beaton** 15 days ago

If the articles themselves don't have the answers, the references will 😊