Part 5

NEW VIEWS OF THE GALAXY: PARALLAXES, DISTANCES AND IMPLICATIONS FOR ASTROPHYSICS

Dave and Alice Monet, Steve Dick; Jesús de Alba at the telescope

left: Fritz Benedict; right: Rick Collins and Steve Higgins

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The (f)utility of ground-based parallaxes

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Abstract. During the 25 years that the author has been involved in astrometry, the quality of ground-based parallaxes has increased by about a factor of 10 (from 3 mas to 0.3 mas), but the quantity has increased by only a few hundred. When asked, the average astronomer will cite the H^2 space missions (Hubble and Hipparcos) as the great advances in astrometry even thought the ground-based work has played a critical role in the understanding classes of stars such as the L- and T-dwarfs. The next decade promises stunning advances in both the quality and quantity of parallax measurements, and both ground- and space-based projects will play significant roles. The Gaia space mission and the various ground-based telescopes with large etendue (DMT, LSST, Pan-STARRS, etc.) will improve the quality or quantity (or both) by factors of a thousand or more. The situation will be discussed, and the author will express his hope that he might live long enough to see the fruits of these labors.

Discussion

Coryn Bailer-Jones: Dave, just to comment on one of your cynical observations, number 2. You rightly mentioned that the equivalent precision which one is trying to get to with Gaia is 50 micropixels, but, of course, the intention is not to get that in a single observation.

Dave Monet: No, that's the end of mission. But that's what you are talking about: characterising your detector over roughly a five-year period such that the systematic errors are the only thing that you have left at that kind of a number.

Coryn Bailer-Jones: Correct, but it's not a single CCD.

Dave Monet: Yes, those were not single exposure numbers. That was the desired accuracy after the end of the mission.

Coryn Bailer-Jones: Right, and that's presumably also the case for your USNO observations.

Dave Monet: Yes, that's right. The playing field was as level as I could make that.

Fritz Benedict: Is all the astrometry done on a single chip in PANSTARS? There's no chip-to-chip astrometry done?

Dave Monet: My hope is that we can do wafer-to-wafer – that is to say each 4k × 4k piece of silicon should have the same thermal stretching blah, blah, blah – and we don't have to solve each 512^2 cells separately; that's the hope. But undoing this OT-CCD guiding as a non-trivial sport because the charges have moved in different directions, so your bookkeeping has to be very good, and that's not something all programmers get right.

Floor ven Leeuwen: There's one area for ground-based astrometry that is completely out of sight for space-based astrometry, and that is globular cluster work. For globular clusters the density towards the core is far too high to deal with by satellites like Gaia. Are we developing ground-based facilities that can cope with globular clusters?

Dave Monet: I guess I'm a bit curious, because I would have thought that in space where you just have λ/d for the size of your PSF ... from the ground you are lucky to get to a tenth of an arc-second. Isn't that about the Adaptive Optics limit for the Keck and other telescopes? Surely you can do better than that in space?

Floor ven Leeuwen: The density of stars per square degree is too high for Gaia.

Dave Monet: Does confusion limit that?

Floor ven Leeuwen: Yes.

Dave Monet: [inaudible comment from Fritz Benedict] ... I'm sorry. I won't give you that, Fritz, I'm sorry. There's no way SIM can handle that kind of density. It would be really cute if somebody could come up with the same kind of concept that we saw for MOST – flying a little suitcase that did the globular clusters correctly. That would be a tremendous ecological niche: build it and fly it for 10 million bucks, point it at 5 or 10 important globular clusters, and walk away with the science. That would be one *really* great opportunity.

Ricky Smart: $R = 24.3$ in the plane? You're just going to be confused out?

Dave Monet: Well, that's where Moore's law comes in, right? I have no idea, no one has really gone to $R = 24$ on the ground. The key is how well can you do relative astrometry on difference imaging. One of the keys of the Pan-STARRS pipeline is to build a deep image of the sky, and then subtract that from your instantaneous frames. That highlights the supernovae, highlights the new objects there. That also helps with crowding a tremendous amount. The OGLE folks are doing that and finding all sorts of cute stuff in otherwise very crowded regions. So I think there's a lot of applied image processing before we give up completely on dense regions – like, if you solve the problem, you can do the globular clusters! Wouldn't it be nice to attract some young blood who still enjoyed computer programming, and got it right occasionally?