Stars in astronomy Director's Perspective 03 May 27
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Steven Beckwith

The other day a friend of mine remarked casually "It seems that all stellar astronomers over the age of 50 have gotten cranky." We had noticed a certain defensiveness in one of our colleagues who thought his interests had been marginalized among more fashionable topics often featured in the popular press. Stellar astronomy dominated the study of the universe for most of the last 400 years, and astronomers who work on stars are following a rich tradition. But a lot of us got the feeling that stars are well understood and have moved on to more exotic pursuits, leaving the stellar astronomers to rethink that rich tradition.

"Stellar" brings to mind "the best and brightest," and when I talk about astronomers who work on "stars," visions of Hollywood and all its glamour come to mind. Indeed, the importance of stars as a subject for human inquiry is embedded in the language whenever we want to describe individual achievement that stands above all the rest. So why are these "stellar astronomers" cranky?

It cannot be because of their success with the Hubble Space Telescope. The Cycle 12 TAC rated a stellar proposal, Fritz Benedict's (#9879) as its highest priority this year among nearly 1100 competitors. Benedict's team will measure the distances to Cepheid variables by direct parallax using the Fine Guidance Sensor (FGS1R) on Hubble; Howard Bond won time for a similar, albeit smaller program to recalibrate the Cepheid zero point luminosity-period (L-p) relationship following precise measurements of the distances to these important stars.

HST is now the most precise instrument in history for measuring the positions of stars, achieving an accuracy of 0.2 milliseconds of arc (mas), about five times better than Hipparcos, the previous state-of-the-art. At that precision, several fundamental problems in astronomy come into reach for the first time. For example, the largest uncertainty in the distance scale of the universe, expressed through H_0, is the zero point calibration of the L-p relation, which Benedict and Bond can improve by a factor of a few to reduce the error in our knowledge of H_0 – and thus the age of the universe.

Bond is using similar techniques to improve our knowledge of binary star masses as a check on stellar evolution theory. There has been a problem with some binary star systems whose components appear to have much different ages from one another when calculated by our standard theory, whereas we expect them to be coeval. Initial observations of Procyon revised the derived masses of the two stars in this binary system downward and brought the observations into agreement with theory for the first time. Bond's team is continuing with observations of several other binary systems. Stellar evolution theory is one of the most important advances of 20^{th} century astrophysics, and its verification remains an essential underpinning for our field.

ER 8 is the coolest known white dwarf in the Galaxy and hence the oldest. It is nearby and moving rapidly, and by chance it will pass within 50 mas of a background star in 2006 causing an apparent shift in the center of light by more than 8 mas owing to gravitational lensing of the star by the white dwarf. This shift is easily detectable with FGS1R, allowing Kailash Sahu and his collaborators to measure the mass of ER 8 to better than 5%. Knowing the mass of this cool white dwarf will allow them to set the best lower limit to the age of the Galaxy yet, and by extrapolation to the universe itself. This measure of universal age is completely independent of the standard methods of cosmology (see H_0 above) and has the potential to either confirm or deny our standard model for the universe. This is not the sort of impact we expect from a device whose main goal is to keep a spacecraft pointed in the right direction, but then Hubble continues to show its superlative capabilities in the least likely areas.

Sumner Starrfield and colleagues recently had their image of the peculiar nova, V838 Mon, on the cover of *Nature*, an image so spectacular that it could displace the Eagle Nebula as Hubble's most iconic image in the public's mind. We already have T-shirts with V838 Mon that are quite popular among the T-shirt wearing crowd (I am thinking of getting a tie with that image or maybe another hat.)

The Fine Guidance Sensors don't get much respect these days, but they are quietly providing opportunities to rewrite the textbooks. FGS1R, installed during servicing mission 3a, has improved the state-of-the-art to such a degree that it opened up a number of new research areas just as all of Hubble's new instruments have. The Cycle 12 TAC recommended programs using the FGS for 5% of the total orbits at the same time that WFPC2 – the venerable camera that is responsible for 90% of the public and more than 50% of the scientific impact of Hubble – received only 2% of the time. This change once again shows how servicing Hubble has expanded the range of its scientific capabilities: FGS1R improved the state-of-the-art for astrometric precision by as much as the Advanced Camera for Surveys improved imaging. Servicing Hubble gives us a lot of bang for the buck, and since it takes a lot of bucks to do it we are pleased to get a correspondingly big bang.

Our stellar astronomers have been flying stealthily below our radar screens to pick off some of the most important problems in astronomy with Hubble's unmatched accuracy. The TAC noticed, I noticed, and pretty soon someone in the science media will notice that a field thought by its own practitioners to be less than fashionable is actually cutting a wide swath through new territory and giving the more glamorous folks a run for their money.

So, if you are a stellar astronomer who is feeling cranky, you may want to take heart in the new opportunities offered by Hubble. It is going to help you rewrite the textbooks as it has with so many other fields.

I, for one, will be cheering you on.