THE BIGGEST, BADDEST, COOLEST STARS
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Summary Session: Where Do We Go From Here?

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Abstract. In the concluding session of this conference, the participants met to discuss the directions that the "cool star" research community should take over the next decade. The authors were the moderators of this session.

1. Introduction

The community of researchers that study the *Biggest, Baddest,* and *Coolest Stars* is relatively small in the field of astronomy. However this group has carried out a large amount of work to understand these stellar types. The discussion carried out in this session was split into two parts, a *theoretical wish list* and an *observational wish list*. Finally, some concluding remarks were discussed.

2. The Theoretical Wish List

A continuation in the improvement of time-dependent dynamic modeling was the first item mentioned. Over the past decade Dr. Susanne Höfner and her colleagues have been important contributors in this line of work for asymptotic giant branch (AGB) stars (see Höfner et al. 2002, 2003; Sandin & Höfner 2003a,b, 2004; Nowotny et al. 2005a,b; Freytag & Höfner 2008). Besides the Mira-type long period variables, many in attendance thought it was important also to start investigating dynamic models of semiregular and irregular variable cool giant stars as well.

Lower-mass AGB stars ($M < 5$–$7\ M_\odot$) fall into three spectral classes: M (with carbon-to-oxygen abundance ratio less than 1, the so-called oxygen-rich stars), C (with C/O >1, the so-called carbon stars), and S (with C/O ≈ 1). The modeling of dust formation in these stars has primarily focused on carbon stars (e.g., Gail & Sedlmayyr 1986, 1987, 1999; Andersen et al. 2003; Schirrmacher et al. 2003). Less work has been completed for modeling the formation of dust in oxygen-rich giants due to the complexities of the physics of the formation of metal oxides, silicates, and iron-based grains (see Ferguson et al. 2001; Ireland & Scholz 2006). Dust formation in the S-type red giants has typically been ignored (Ferrarotti & Gail 2002). It was the desire of many in the audience for an aggressive effort to improve dust formation modeling in the M-type and S-type giant stars. Such work would be invaluable to understand the physics of silicon-based dust in a dynamic atmosphere since such dust has long formation

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times and is thought to be an important component in the mass-loss mechanisms of these stars.

3. The Observational Wish List

There was a strong desire by the participants for an increase in observations to deduce mass loss in AGB stars and to try and deduce from these observations the location in the stellar atmospheres of these stars where such mass loss begins — is the main driving force in the photosphere or in the circumstellar shell of these stars? Does the dust opacity change with time during a pulsation cycle in the Mira stars? Continuous synoptic monitoring of the spectra and photometry of these stars would be useful to answer this question. Such work could be carried out by the amateur astronomy community and by undergraduate students at small colleges with their results being reported to and cataloged by the American Association of Variable Star Observers (AAVSO) and the National Virtual Observatory (NVO). Many thought it was important to encourage scientists and amateurs to make their data archives public.

Interferometry observations with multiple baselines show great promise for the stars considered in this conference, both to study their winds and their atmospheres. Participants were particular eager to see such observations covering a complete pulsation cycle for a large number of Mira-type and semiregular variables.

More spectral observations in the submillimeter for oxygen-rich red giant stars are desired. In addition, weekly high-dispersion spectral observations of the Fe I and Fe II lines in the blue-violet region of the spectrum are needed to continuously monitor the wind of these stars to see if any variability is seen over time.

The fraction of astronomers studying the stars directly has been shrinking in recent years, particularly in the United States, as interest has grown in both larger scale (galactic and cosmological) and smaller scale (extrasolar planetary) systems. An understanding of stars remains essential across these scales, and as we have seen here, there are interesting, fundamental and important questions left to be answered. Some thought it would be useful for more stellar astronomers to serve on telescope allocation committees and serve on referee panels on NASA, NSF, and NOAO panels. It was pointed out that NOAO has a useful web site called ReSTAR (see http://www.noao.edu/system/restar/): Renewing Small Telescopes for Astronomical Research. Such telescopes are an extremely important resource for the type of work being described here.

4. Conclusion

This session concluded the conference on the *Biggest, Baddest, Coolest Stars*. Those in attendance thought that small meetings of this size were very beneficial in the exchange of new ideas in astronomical research. Indeed many thought that more meetings like this one is desirable in the future.

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