

Ecology of Blue Straggler Stars

held at ESO Vitacura, Santiago, Chile, 5–9 November 2012

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The last workshop dedicated to blue straggler stars (BSS) took place 20 years ago and there have been a great number of subsequent developments since in both observations and theory. The wide range of BSS topics covered at the workshop are briefly summarised; the published proceedings will form the first book on the subject.

The existence of blue straggler stars (BSS), which appear younger, hotter, and more massive than their siblings, is at odds with a simple picture of stellar evolution, as such stars should have exhausted their nuclear fuel and evolved long ago to become cooling white dwarfs. With the many advances in observational and theoretical work on blue straggler stars, the time was considered ripe for a dedicated workshop to summarise the current state of the field, identify the many still open questions and define in a coordinated way new avenues of research to address these issues. The resulting workshop brought together specialists in binaries and multiple star

systems, stellar evolution and stellar populations, as well as the dynamics of clusters. The chosen format of the event (i.e., a low number of participants and a large amount of time devoted to discussion) resulted in a very lively workshop, which was much appreciated by the participants. The discussions were triggered by the very detailed and useful invited talks — no less than 12 were given — providing a unique and insightful view on the field.

The introductory talk by R. Cannon reminded us of the first discovery of blue straggler stars in 1953 by Alan Sandage in the globular cluster M53, as well as the fact that the only previous proper workshop on BSS took place in October 1992, at the Space Telescope Institute, i.e. 20 years ago! It was also Cannon who recalled that the germ of the idea that BSS are due to binaries was planted by none other than Fred Hoyle, only two years after their discovery, as well as by John Crawford in the same year, and then further developed by William McCrea in 1964.

Observations of BSS

As is typical for astronomical conferences, the first few days were dedicated to a review of the observational evidence, clearly demonstrating that BSS are ubiquitous: they exist in globular clusters

(talk by F. Ferraro), in open clusters (talks by R. Mathieu and J. Ahumada) and in nearby dwarf galaxies (Y. Momany). Field blue stragglers have also been identified from their anomalous kinematics and chemical abundances (G. Preston). These reviews revealed the fantastic advances made in the field in the past decades.

Ferraro and his group discussed the challenges associated with observing these relatively faint stars in overcrowded stellar regions, such as the cores of globular clusters, and the key advances obtained through high-resolution ultraviolet (UV) photometry. The speakers provided detailed evidence that BSS are a common population found in each globular cluster properly observed, with some clusters (e.g., M80) having more than 100 identified BSS. The observations of many clusters allow a comparative analysis of BSS in globular clusters with different physical parameters to be made, showing the clear connection that is emerging between BSS properties and the parent cluster dynamical evolution. Indeed, the shape of the BSS radial distribution provides a record of the degree of dynamical evolution experienced to date by the parent cluster, indicating how efficient dynamical friction has been, while the presence of double BSS sequences in

Figure 1. The conference photograph in the grounds of ESO Vitacura.



the colour–magnitude diagram could testify to, and even date, the occurrence of the cluster core collapse event. Ferraro’s group also presented exhaustive chemical and kinematical analysis of BSS in globular clusters.

R. Mathieu presented a fine study of the BSS population in the open cluster NGC 188, allowing him and his colleagues to perform “micro-astronomics”, i.e., determination of the binary frequency and study of the distributions of the orbital parameters (period, eccentricity and secondary mass). G. Preston did the same for the BSS in the field, and the conclusion of both these studies is that BSS present a high binary fraction, with orbital periods of 1000 days, low orbital eccentricities and typical secondary masses of $0.5 M_{\odot}$. Whether this is similar to the population of BSS in globular clusters is still unknown, but such properties are, as explained by H. Boffin, very reminiscent of the population of barium and other peculiar red giant stars, and thus possibly the result of wind mass transfer from an asymptotic giant branch (AGB) star. The fact that most field BSS are s-process enriched — the exact signature of barium stars — is thus perhaps no surprise, even though much more work is required to connect the two categories of stars.

Interpreting BSS

Following the observational talks, the next days were devoted to the theory and the interpretation of the data. As mentioned, Boffin reviewed the scenario of mass transfer by winds, while N. Ivanova covered Roche lobe overflow. If the latter mass transfer scenario is most likely to occur in the very short period systems (with orbital period of a few days or less), the crucial question is to know under which conditions mass transfer from an AGB star could be stable, so as to avoid the common-envelope (CE) phase. Formation of a CE is thought to cause a dramatic shrinkage of the orbit and thus would not allow the long orbital periods observed in open clusters to be explained. The recent results from Ivanova’s group

seem to indicate that mass transfer from a giant star may be much more stable than previously thought, leaving a much wider parameter range to explain the existence of BSS. However, it is not certain that this mass transfer happens early enough that plenty of mass is still available to be transferred, a pre-requisite for a BSS.

H. Perets, M. Davies and A. Geller presented the possible formation channels for BSS in various environments, S. McMillan reviewed the dynamical evolution of globular clusters and how BSS fit into the picture, while C. Knigge and A. Sills showed detailed confrontations between the theory and observations. In some cases, data exist that are precise enough to derive detailed information on the characteristics of some blue straggler systems (namely mass, temperature and luminosity), to enable comparison with evolutionary tracks and mass transfer modelling. There were indeed a few surprises: as several reviewers indicated, it is still unclear how to produce BSS with their observed luminosities, which appear to be much too low for their mass, or how one can even produce BSS with such high masses. Similarly, it was generally assumed that two mechanisms were responsible for blue straggler stars — merger and mass transfer — both of which can operate in the same cluster: the exact preponderance of one mechanism over the other possibly depending on the cluster’s property, that is, the blue straggler’s ecology. The wealth of observations reviewed during the workshop showed that it is still impossible to conclude whether stellar collisions do occur, and could create some BSS. More work is clearly still required in this area.

The last invited talk, by L. Deng, showed the importance of BSS in stellar population synthesis, and how the presence of BSS can dramatically alter the observables of distant systems — their neglect can lead to large errors in the inferred spectrophotometric properties of galaxies. The last word was given to R. Mathieu who brilliantly summarised the workshop and led the final discussion.

As R. Cannon also reminded us during his introductory talk, the few good reviews about BSS date back to the 1990s and no dedicated book exists on this exciting topic. We have thus decided to remedy this situation and make use of the unique expertise gathered by the workshop to produce the first ever book dedicated to BSS. The book will be published by Springer in its Astronomy and Astrophysics Library Series and will contain major chapters from all the invited speakers, edited by us. We aim at producing a book that will appeal to a large community of researchers and especially to graduate students. The book should appear by the year’s end. In the meantime, you can still view the presentations and watch some of the recorded talks on the conference web page¹.

Acknowledgements

It is a pleasure to thank all the participants for contributing so actively to the workshop, and especially the invited speakers for providing very clear and exhaustive reviews of their respective areas. Special thanks go to Bob Mathieu for providing an illuminating and entertaining summary talk, from which we unashamedly borrowed to write the present report. Warm thanks also go to the Local Organising Committee for the smooth organisation of the workshop.

Links

¹ Ecology of BSS workshop pages: <http://www.eso.org/sci/meetings/2012/bss2012.html>