

## CONCLUDING REMARKS

R. G. Smith

Department of Physics, University College, University of New South Wales, Australian Defence Force Academy

### 1. INTRODUCTION

The workshop covered such a wide range of topics, ranging from the stellar contents and the open clusters of the  $\eta$  Carinae region, the Carina nebula, the  $\eta$  Carinae object itself, the galactic structure in the direction of Carina, and finally a comparison with other H II regions, that it is almost impossible to do justice to them all. In view of this, I will confine myself to selecting some highlights from the presentations and add to this some general impressions on current and future directions for research on this quite unique "Laboratory of Stellar Evolution".

Many years ago in the late 1970s I started a project that developed into an intensive study of the stars in the Carina nebula in the infrared and spanned many years as part of my Ph.D. studies. This eventually involved so many hours staring at the nebula through a telescope eyepiece that I came to know each of the stars by name (or more accurately, number). Infrared photometry alone was of limited value in determining what type of stars I was looking at, and when I searched for *UBVRI* photometry of these stars I discovered that a group in Argentina had done a large amount of work on the Carina region. Thus, I had two reasons to be interested in the proposal for a workshop on Carina. The first was learning the current status of work on this area. The second, which no doubt applies for many others who had read the work of Feinstein, Marraco and Forte and others in Argentina, of Thé in Holland, of Herbst in Canada, of Walborn and more recently Davidson in the U.S.A., of Tapia in México, of Roth in Chile, of Dave Allen in Australia and of a host of others from all over the world who have worked on different aspects of the Carina nebula or  $\eta$  Carinae itself, was that this workshop provided a rather unique opportunity for many of these people to get together, often for the first time, to discuss their work and ideas on a personal level. Given that some 70 people in all signed up for the workshop, this must be regarded as one of its major successes. Unfortunately not everyone was able to attend, a situation that was not helped by a strike by the staff of one of the major US airlines. Nevertheless a list of the workshop participants still looks like a Who's-Who of people who have worked on the Carina region, and the workshop must be regarded as a major success for the organizers because of this.

It would be hard to find a more congenial place to hold an astronomical workshop than the La Plata Observatory and our welcome in La Plata for the start of the meeting was quite unique compared with others I have attended and was very enjoyable. We were welcomed on the first evening with a concert in the dome of the large refractor telescope. Starting off the series of talks that were to follow over the next three days, R. Viotti presented an historical overview of the  $\eta$  Carinae region, touching on such topics as the controversy that surrounded Herschel's first drawings of the region in 1838 which showed the "Keyhole" nebula surrounding  $\eta$  Carinae with a bright rim of emission in the south, whereas in later drawings and photographs it is absent. The extreme brightening of  $\eta$  Carinae in the 1840s received some attention, as did the gradual fading and the series of lesser brightenings or nova-like events that took place in the following decades which it seems might occur at predictable intervals.

### 2. THE $\eta$ CARINAЕ OBJECT

For many astronomers  $\eta$  Carinae was and probably is the most interesting object in the region. In the recent work on  $\eta$  Carinae one could not help being struck by the huge range of observations that have been made, from X-ray through to radio wavelengths, all with increasingly higher spatial resolution. Of course, the *HST* images presented by G. Weigelt sparked a lot of discussion. At even higher resolution, speckle observations have shown that there are several compact "objects" in the core of  $\eta$  Carinae, however, spectroscopic observations from the *HST* seem to suggest that only one of these is self-luminous (the "true"  $\eta$  Carinae) and the others are condensations or knots that are reflecting the light of  $\eta$  Carinae.

At longer wavelengths Bob Duncan showed some 1 arcsec resolution radio maps of  $\eta$  Carinae obtained with the ATNF which were quite similar in appearance to images in the mid-infrared. The mid-infrared polarization image of  $\eta$  Carinae presented by Toby Moore was particularly impressive. Polarization images may also be

the means by which some of the structure in the visible images is finally unravelled. Certainly higher spatial resolution imaging has shown more structure around  $\eta$  Carinae which we need to understand, and clearly more information (observational) is needed to understand the dynamics of material close to this object (some Fabry-Perot work might be a big help here, as well.) Overall, I don't see that we completely understand  $\eta$  Carinae, not with questions like whether an accretion disk exists or not, being tossed around. What also appeared to be lacking was someone working on detailed theoretical models of this object.

### 3. THE CARINA NEBULA

The Carina nebula received as much attention as  $\eta$  Carinae itself, and justifiably so. Carina contains the largest concentration of the hottest, brightest, and most massive stars in the galaxy, one of which is, of course,  $\eta$  Carinae. The most visible effect of so many O and B stars is the complex and very extensive ionized emission from the nebula. The other consequence of the presence of these massive stars and the huge amounts of high-energy radiation they emit is their effect on the dust in the nebula. You might think that understanding the Carina nebula is an easier problem than trying to understand  $\eta$  Carinae, certainly the galactic structure in the region looks secure. However, while several presentations, by Nolan Walborn and others, demonstrated the progress that has been made in understanding the stellar content of the nebula and the evolution of massive stars, they also highlighted how much more we need to do to understand these stars. Many more have now been found in the Magellanic Clouds, but it seems there is still no satisfactory explanation as to why so many should form in Carina.

Alejandro Feinstein gave us an overview of the many open clusters that can be associated with the Carina region and there were impressive presentations of large-scale visible and infrared images made from mosaics of CCD images. Photometry from these images is being used to study the extinction in the region and to look for local variations in the extinction. Some good examples of these mosaics were the *UBVRI* and *JHK* images obtained by M. Tapia and M. Roth and their collaborators. Pik-Sin Thé and M. Tapia summarized the work on the extinction law in the visible and infrared in the nebula. While most people agree that the extinction law in the region is anomalous, there was not complete agreement on the interpretation of this data. It was clear also that there is still much more to learn about the composition of the gas and dust in the nebula. The images of the stellar population in Carina were not just confined to the visible and infrared. Many of the O-stars in Carina are hot enough to emit appreciable amounts of X-rays, and this was very well illustrated by the *ROSAT* images presented by M. Corcoran.

### 4. SUMMARY AND CONCLUSIONS

From the series of talks and posters that were presented over the three days of the workshop I was left with two distinct impressions; (i) there are still plenty of unsolved problems left in Carina, and so there are plenty of opportunities left for students to study the Carina nebula (or  $\eta$  Carinae), and (ii) more generally, I think we have seen that studies at many wavelengths are very effective for enhancing our understanding of the problems (P. Cox gave us an excellent illustration of this in his talk on the molecular content of the nebula). I used the word "enhancing" rather than "solving" when referring to the outstanding problems because it seems to me that solutions are still some way in the future. Hopefully this workshop will even lead to new collaborations between groups working at different wavelengths, or with different techniques. Perhaps the proposed " $\eta$  Carinae" electronic newsletter will help bring the existing groups together and get them talking to each other more. Less frequently, workshops such as this one are an excellent way to get us all together to discuss Carina, present new data, and try out new ideas, and all the participants are to be congratulated on their efforts. I would like to see a workshop on Carina as a regular event, perhaps every 5 years or so to provide personal contact between what is now a large number of people working on this region. Maybe we can even consider hosting the next workshop in Australia.

From my experience with conferences and workshops, I know the enormous amount of effort involved and I know how disruptive to daily life this can be; it is only necessary to look at the work put in by the organizers to see a fraction of this. I would like to add my thanks to these people, A. Feinstein, the local organizing committee, the rest of the staff of the observatory, and all the students who seem to have been doing so much work throughout the workshop. All these people are to be congratulated on organizing such an excellent and memorable workshop.