THE SMC CLUSTER NGC330

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The cluster NGC330 is compact, populous, and one of the brightest objects in the Small Magellanic Cloud. Because of its size and its large number of blue supergiants, it has been referred to as a "blue globular", as have several other clusters in the Clouds. To learn whether this appellation is more than superficial, we have undertaken a general study of the cluster. We have obtained *DDO* photometry, photoelectric and photographic *UBV* photometry, and low-dispersion spectroscopy of stars in and near the cluster. We report here our preliminary analyses of the data.

I. *DDO* Photometry. The *DDO* photometry of several red supergiants form sequences in the [$C$(45-48)-$C$(42-45)] and [$C$(41-42)-$C$(42-45)] diagrams that are indistinguishable from those of the galactic globular cluster M3. This implies comparable surface gravities and cyanogen strengths for the stars of both clusters. Since the NGC330 stars are intrinsically about three magnitudes more luminous than the M3 stars, the comparable surface gravities suggest the former stars are about 10 times as massive as the latter, so that the NGC330 turnoff mass probably exceeds 8 $M_{\odot}$. The similar compositions suggest that NGC330 is very metal-poor, for [Fe/H] of M3 is about -1.7 (Searle and Zinn 1978).

II. *UBV* Photometry. We have remeasured Arp's (1959) photoelectric *UBV* sequence, plus additional stars, for a total of 44 measures of 26 stars with $12 < V < 17$. Agreement with the sequences of Arp (1959) and Robertson (1974) are good at the bright end, but poorer at the faint end. To extend the photometry, the Racine prism attached to the CTIO 4-meter telescope yielded $V$ and $B$ plates with limiting magnitudes near $V = 20$, or $M_V = +1$. Iris photometry of one plate pair yields a color-magnitude diagram with a main sequence well-populated to the plate limit, and a confirmation of Arp's conclusion that the cluster is young ($\sim 10^7$ y).



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III. Spectroscopy. We have obtained 34 spectrograms of 19 stars in the cluster field, using the Yale 1-meter telescope at CTIO and the Boller and Chivens spectrograph at a dispersion of 121 A $mm^{-1}$. The three apparent yellow supergiants are normal galactic F dwarfs, but all the other stars are SMC members. Spectral classification of nine early-type stars yields a reddening of $E(B-V) = 0.04 \pm .01$.

Several spectrograms were obtained with the slit oriented E-W across the cluster. The observed tilt of the integrated cluster spectral lines suggests rapid rotation, with a velocity difference of about 100 km $s^{-1}$. If rotation is responsible, a cluster mass in excess of $10^6 M_\odot$ is indicated. We plan to obtain more integrated cluster spectrograms.

In summary, we find NGC330 to be about $10^7$ y old, very metal-poor, massive, and to contain a well-populated main sequence to at least $M_V = +1$. Is NGC330 a young Population II system?

REFERENCES

Arp, H.: 1959, *Astron. J.* 64, 254.
Robertson, J.W.: 1974, *Astron. Astrophys. Suppl.* 15, 261.
Searle, L., and Zinn, R.: 1978, *Astrophys. J.* 225, 357.

DISCUSSION

*HODGE:* You don't want to pass your spectrum around? (Laughter).

*JANES:* Well, I thought about trying to put it in the slide projector, but I would like to preserve it!

*FEAST:* I'd like to make three points. Firstly, as regards the photometry of the inner parts, my guess would be that it's best to use Robertson's work rather than Arp's, because with the early type stars, there was a disagreement between the spectral types that I got and Arp's photometry which went away when you use Robertson's photometry. So I suspect that Robertson's is better in a sense.

*JANES:* Yes, I should make myself clear. The photographic stuff is based on our photometry, and it seems to agree with Robertson's. I plotted Arp's inner estimates, as they came from Arp, and they should be basically moved to lower luminosity, for the ones on the turnoff. He had them too bright in *V*, so that shouldn't be compared too closely with ours. But the photographic stuff is based on our sequence, rather than Arp's.

*FEAST:* The second thing I wanted to say was that I have recently published some spectral types and I think that I can, in the late-type stars, see signs of metal weakness in the stars which, of course, Arp thought was there long ago and I didn't. But I think there are different signs from the spectra of metal weakness. And thirdly, what is on the board outside is to say that the velocity dispersion is very low. I'd like to ask you about your integrated spectrum. It surprises me a bit because I think that I have got at home quite a number of integrated spectra, and maybe I just missed it, but I suspect that I would have noticed something. I know that I've got something in which I put the cluster out of focus. I wonder if you have the cluster out of focus or in focus?

*JANES:* No, I did have it in focus. This is possibly an important point in that, in fact, of the several exposures that I have, the shortest one shows a series of streaks of individual stars, but they do seem to form in the same sort of progression. That's why I mentioned that maybe a few stars dominate the spectra.

*FEAST:* And could I make one last point, and that is one of the things that interests me about the very low velocity dispersion that I got, namely, that it seems to imply that there can't be very many spectroscopic binaries. This may be tied up with something that I found a few years ago which is on or near the top of the main sequence: there are a great number of Be stars, and this may be related in that there may be very few spectroscopic binaries among the Be stars.

*JANES:* Now, of course, the stars that you have are mostly some distance from the centre of the cluster?

*FEAST:* Yes, they're the ones for which Robertson and Arp got photometry, essentially.

*RENZINI:* If the mass is $10^6$ $M_\odot$, then what is M/L?

*JANES:* It is $\sim$ 10, which is dramatically different from the other numbers we have heard today.

*FEAST:* You see, I think it's less than 0.1. (Laughter).

*ALCAINO:* For the Racine wedge, have you used a 6.9 mag value quoted between the primary and the secondary images in the CTIO Facilities Manual or have you calibrated the wedge, which is the logical thing to do?

*JANES:* I calibrated it myself.

*ALCAINO:* If that was the case, what were your results for the standard deviations and how many secondaries did you loose which fell on top of other stars?

*JANES:* Yes, that's a real problem, of course; in such a crowded field the secondary images get buried behind the faint stars. I took plates of 47 Tuc right before this to calibrate the wedge, so I only had to move the telescope a couple of degrees. I also went a little further afield to find some very bright stars

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that had photometry in order to add to the statistics of it. I would not be surprised to see that problems such as the funny little kink at the bottom of the main sequence stem from the wedge. I don't remember the numbers, but the calibration curves seem to be quite smooth with this one plate pair with a dispersion of 0.05 to 0.07 mag, so they seemed quite good.

*ALCAINO:* You don't recall how close it was to 6.9?

*JANES:* It was 6.83 mag.

*ALCAINO:* It is exactly the same result that I used for NGC 6397.

*JANES:* I'm glad to hear that.

*FREEMAN:* I'm not going to identify myself - I don't want this question recorded. It's an ignorant question following on what Mike Feast was saying about spectroscope binaries and B emission stars. Are the Be stars believed to be rotaters?

*JANES:* Yes, this is exactly what Abt found in the general field, that there was a lack of spectroscope binaries amongst Be stars.