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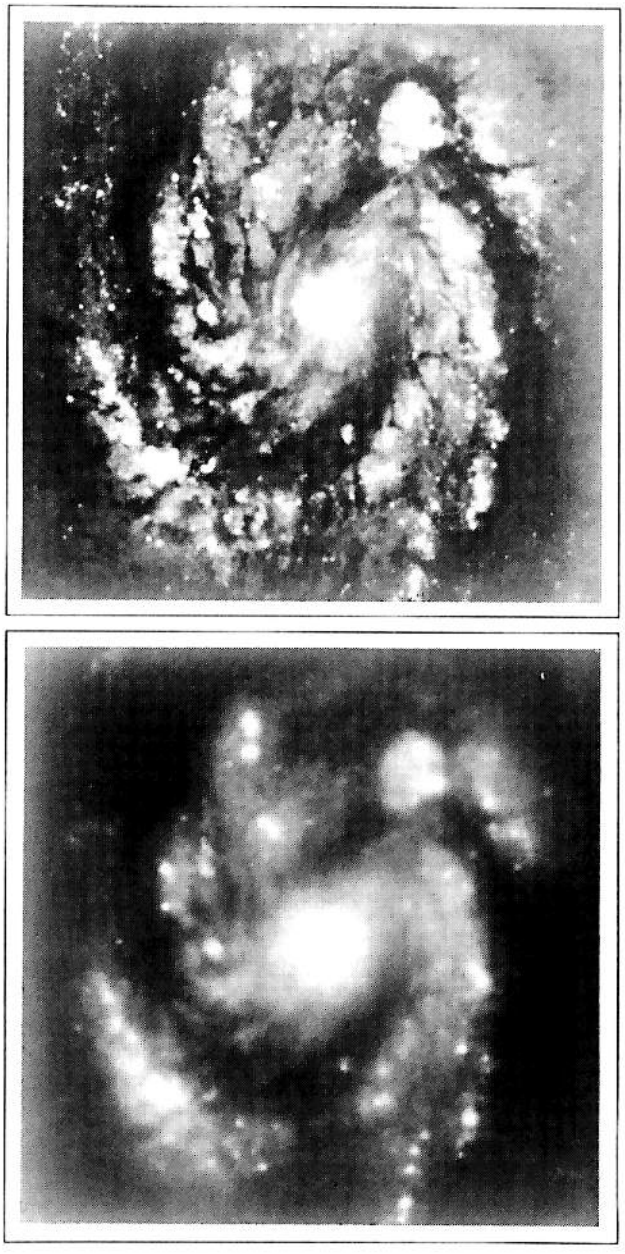

Fig. 1: A comparison image of the core of the galaxy M100. Top panel: WFPC2 image taken on December 31, 1993 Bottom panel: WF/PC-1 image taken on November 27, 1993.

Highlights of this Issue

HST SCIENCE HIGHLIGHTS

EARLY RELEASE OBSERVATIONS WITH THE REFURBISHED *HST*

The Early Release Observations, or ERO, refer to the first images that were taken of science targets by *HST*, following correction of the spherical aberration in the optics. All observations obtained under the auspices of the ERO program were drawn from existing science programs, both GO and GTO, although the ERO program itself is separate from those science programs. The goals of the program were to make observations that would demonstrate the nature of the optical correction, while maintaining the science content needed to illustrate and assess the capabilities of the new *HST*. For example, images of M100 not only provided a dramatic illustration of the effect of the optical correction (improved dynamic range, sensitivity to faint sources, increased resolution), but also demonstrate the capability of *HST* to measure Cepheid variables at Virgo Cluster distances.

The optical alignments for both the WFPC2 and FOC/COSTAR proceeded quickly, well ahead of schedule. The ERO observations thus began shortly before the New Year. The first ERO target observed with the WFPC2 was Orion, followed in rapid succession by quasar host galaxies, M100 and Eta Carinae, and R136a and a distant cluster early in 1994. FOC/COSTAR imaging began at the end of the first week in January, with observations of Nova Cyg, SN1987A, NGC1068 and the globular cluster 47 Tuc.

A few of these targets await release to the public, which will occur in the next few weeks. We review here the observations that have been released. Color gif versions of the images are available on STEIS, while the proprietary situation for the original digital data is summarized below (some but not all of the data is public).

A primary target was M100, a picture-perfect spiral galaxy in the Virgo Cluster and one of the target galaxies of the Key Project on the Extragalactic Distance Scale (Mould *et al.*). The aim of the Key Project is to measure direct Cepheid distances to about two dozen galaxies out to distances as far as the Virgo cluster. These distances will provide an accurate calibration of several independent secondary distance indicators; the ultimate goal of the program is to measure the Hubble constant to an accuracy of 10%.

The observations comprised B, V and R WFPC2 images. Fig. 1 shows a comparison of the nuclear region of M100 taken with WF/PC-1 to the new WFPC2 image (raw data in both cases). The smoothing and degradation in S/N that was caused by the halo of the spherically aberrated PSF is immediately obvious. Fig. 2 shows the nuclear view in the context of the galaxy as a whole. For a ground based picture, the Sandage-Bedke atlas may be consulted; it covers about twice the area of the full WFPC2 field. The resolution is striking in that the picture of the nucleus could be mistaken for an entire galaxy. We stress that it covers only the inner few kiloparsecs.

For a more quantitative assessment of the new *HST* capabilities, Fig. 3 shows a small portion of the same field as observed with WFPC2 and WF/PC-1, as well as a WF/PC-1 deconvolved and a ground-based image. The stars indicated are approximately of the luminosity expected for brighter Cepheids, although at this stage we do

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not know if these particular stars are actually Cepheids. The gain in sensitivity to faint stars is obvious. The Extragalactic Distance Scale team has already undertaken photometry of the resolved stars on the new images (Freedman *et al.* 1994, *ApJ Let*, in preparation). Preliminary color-magnitude diagrams show the presence of blue supergiants covering a range of over four magnitudes. The photometry shows good external agreement for the two epochs of data available, with rms differences ranging from ± 0.02 mag for the brightest stars to less than ± 0.1 mag for stars that are four magnitudes fainter. The luminosity function of these blue stars has been measured and its slope agrees extremely well with that determined in nearby galaxies. This is the first such luminosity function determination outside of the Local Group. In addition, the position of the Cepheid instability strip in the color-magnitude diagram already reveals several dozen Cepheid candidates, and demonstrates that measuring Cepheid distances out to the Virgo cluster is feasible with the refurbished *HST*. A sequence of observations with longer exposure times will be obtained in Cycle 4. This will allow for a determination of the periods of the Cepheid candidate stars and therefore of the distance to this Virgo galaxy.

The ERO data of the nuclear region of M100 (Fig. 1) also illustrate the ability of WFPC2 to chart the still poorly known centers of nearby galaxies. The WFPC2 images of the high surface brightness inner disk of M100 reveal three structural zones: (1) Spiral arms dominate the outer part of the nuclear disk, and eventually become confused with the main two-arm spiral pattern of M100. Outlined by pronounced dust lanes, the outer nuclear spiral pattern is broken only when the spiral lane splits around a luminous "island." Star clusters, and perhaps extreme supergiants, are frequent between the dust lanes in the outer half of the nuclear zone. These concentrations of young, stellar Population I objects evidently constitute the pseudo-ring that is seen from the ground. (2) Within the inner one-third of the nuclear disk the surface density of stellar objects declines, suggesting that the star formation rate, and thus density of young stars, declines near the nucleus. In this area the dust structures become more complex and the two-arm dust pattern is lost in a swirl of dark filaments around the nucleus. (3) The center of the galaxy contains a bright nucleus which is partially resolved, and is possibly surrounded by a bulge.