

H U B B L E

15 YEARS OF DISCOVERY

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This book is dedicated to all the hard working people in the USA and Europe who have made the Hubble Space Telescope an incredible scientific success

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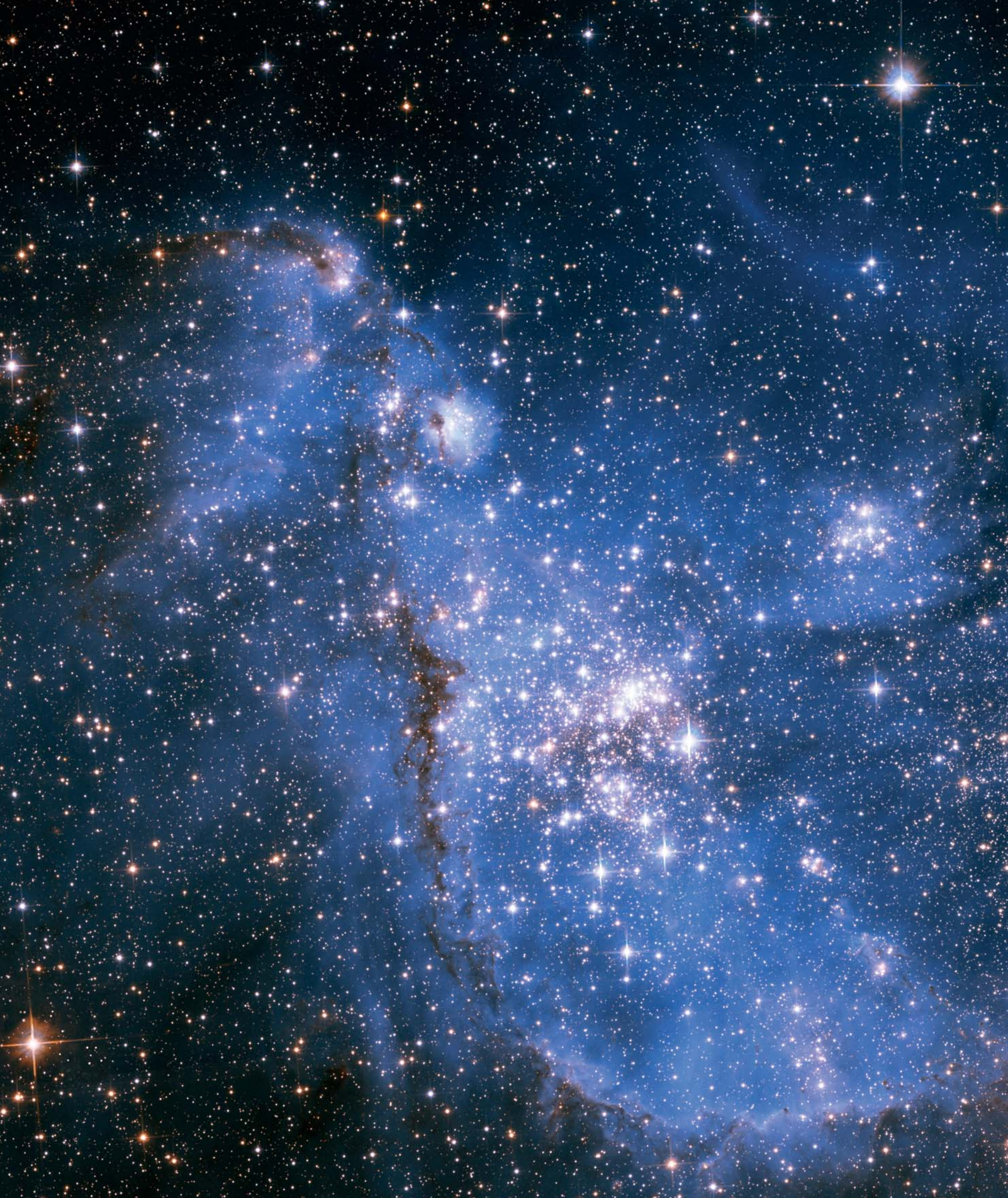
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The Sombrero Galaxy

The Sombrero galaxy is one of the Universe's most stately and photogenic galaxies. The galaxy's hallmark is a brilliant white, bulbous core encircled by thick dust lanes comprising the spiral structure of the galaxy.

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FOREWORD

NGC 346

Hubble's exquisite sharpness has
plucked out an underlying
population of infant stars
embedded in the nebula NGC 346
that are still forming from
gravitationally collapsing gas
clouds.

The Hubble Space Telescope has undoubtedly had a greater public impact than any other space astronomy mission ever. The images included in this beautiful volume are quite staggering in what they reveal about the Universe we live in and have already become part of our common scientific and cultural heritage.

But what about the science impact? It is no exaggeration to say that the scientific output of the mission has far exceeded the most optimistic expectations of all those involved in the planning and execution of the project. When I joined the project in 1977, I had to describe the astronomy programme I would carry out with the Hubble once it was in operation in orbit. Seventeen years later when I received my first data, I was quite staggered by the quality of the images and also by the totally new science which they revealed about the ways in which relativistic jets can illuminate the environments of active galaxies. This is a repeated theme in essentially all areas explored by the Telescope. The images are not only beautiful, but are full of spectacular new science, much of it undreamed of by the astronomers involved. A good example is the discovery of protostellar discs seen in silhouette against the bright background of the Orion Nebula. Another is the ability to discover distant star forming galaxies by imaging in a number of wavebands. The observation of distant supernovae has enabled the present acceleration of the Universe as a whole to be measured – an undoubted triumph. And then there are the spectacular images of the Hubble Deep and Ultra-Deep Fields which have revealed what are almost certainly young galaxies in the process of forming the galaxies and larger scale structures we observe about us today. But these are only a few random samples of the wealth of scientific knowledge which has accrued from the mission. Every picture tells a wonderful story which has already been built into our picture of the evolving Universe.

What are the lessons to be learned from this spectacular success? The route to new understanding is through the ability to observe the Universe in new ways with techniques, that extend observational capability by a factor of 10 or more. In the case of the Hubble Space Telescope, the gains in angular resolution, or sharpness, and corresponding sensitivity, as well as the remarkable stability of the instruments in the remote environment of space, have given it unprecedented power to uncover new astrophysics. The results are a wonderful tribute to the dedicated efforts of many scientists, astronomers, engineers, managers and administrators, as well as to the vision of NASA and ESA in enabling the Hubble Space Telescope to come about. Long may this vision and the ability to inspire the public imagination continue as an essential means of deepening our understanding of the Universe.

Malcolm Longair

4 April 2005



PREFACE

The Cone Nebula

Radiation from hot, young stars

(located beyond the top of the

image) has slowly eroded the

nebula over millions of years.

Ultraviolet light heats the edges of

the dark cloud, releasing gas into

the relatively empty region of

surrounding space.

The long-term wellbeing and cultural development of humanity depend on scientific research and technological development. The communication of scientific discoveries and information about scientists and their work to the public are vital components of the scientific process. However, the competition for attention in today's mass-media market is fierce.

This book takes a closer look at what may be the world's most successful scientific project. The fifteenth anniversary of Hubble's launch, which took place on the 24th April 1990, presented the ideal opportunity for a spectacular project to seize the attention of the public. The story of a journey through space and time revealed by the telescope is told in a way that we hope will appeal especially to the younger generation. It will be their enthusiasm that powers the future of the scientific endeavour.

We should like to thank Stefania Varano, Stuart Clark and Anne Rhodes who all worked on the film manuscript that laid the foundation for important parts of this book. Unless otherwise noted, the images in this book were taken by the NASA/ESA Hubble Space Telescope and should be credited to NASA, ESA and the individual scientists (see www.spacetelescope.org for the exact details).

Lars Lindberg Christensen and Bob Fosbury

Munich, 23 November 2005



INTRODUCTION

NGC 1300

NGC 1300 is considered to be prototypical of barred spiral galaxies. Barred spirals differ from normal spiral galaxies in that the arms of the galaxy do not spiral all the way into the centre, but are connected to the two ends of a straight bar of stars containing the nucleus at its centre.

On 24 April 2005 the NASA/ESA Hubble Space Telescope will exceed its original estimated lifetime of 15 years in orbit around the Earth. Hubble has been hugely successful in many different areas of astronomy. How does it differ from other famous telescopes?

Hubble orbits 600 km above the Earth's surface, placing it well above our image-distorting atmosphere. It can be upgraded to take advantage of the latest developments in instrumentation and software. The telescope is designed to take high-resolution images and accurate spectra by concentrating light to form sharper images than are possible from the ground, where the atmospheric 'twinkling' of the stars limits the clarity. Therefore, despite its relatively modest aperture of 2.4 metres, Hubble is more than able to compete with ground-based telescopes that have light-collecting (i.e. mirror) areas 10 or even 20 times larger.

As well as being able to take sharper wide-field images, the other huge advantage Hubble has over ground-based telescopes is its ability to observe the near-infrared and ultraviolet light that is otherwise filtered away or masked by the atmosphere before it can reach the ground.

In many areas of astronomical investigation, Hubble has pushed the limit of our knowledge far, far beyond anything possible before its launch.

