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## PREFACE

**A**stronomy is one of the oldest sciences. The stars were studied systematically in the ancient civilizations of Babylon, Egypt, China, and Central America as early as the third millennium before Christ. Such observations were used for measuring time and for constructing calendars. Those astronomers were able to predict eclipses of the sun and of the moon, as well as the positions of the planets. During the sixth and fifth centuries before Christ, the Greeks continued building on the achievements of the Babylonian astronomers. Important milestones in the history of astronomy include the theory of heliocentricity (which superseded the Ptolemaic view), the discovery of Kepler's laws, and the mathematical formulation of celestial mechanics. By means of these laws, various calculations and predictions could be made about the planets, their satellites, and the comets. Astrophysics became a science in the 19th century, and in the 20th century radio astronomy was developed, as well as infrared, x-ray, and gamma-ray astronomy. Early ventures into space culminated in the first moon landing on July 20, 1969. Astronomical facts have a special fascination for scientists as well as laymen.



*The problems of astronomy:* As a science, astronomy attempts to explain the immeasurable aspects of space in measurable terms — a nearly impossible task. Physical laws which are valid on earth are applied to the entire universe. Thus, astronomy becomes applied physics on the largest scale imaginable. Matter occurring in space is no different from that of which the earth is made, but it is subject to conditions unobtainable on earth. Pressure and density can be so extreme as to be totally unknown on earth. Matter (atoms and electrons) can be so tightly packed that the total mass of the earth could be compressed into a thimble. On the other hand, space can be so empty that a cubic meter contains only one atom of hydrogen.

*The limitations of astronomy:* Every science has its limitations and boundaries which cannot be crossed, no matter how hard we try. In the words of one astronomer, “The only available tangibles are a few exposed photographic plates, recordings of radio signals from space and from space probes, some rocks from the moon, and meteorites which have fallen from the sky.” Harold Urey, who won a Nobel prize for chemistry, brashly declared that he would explain the origin of the universe by studying one moon rock. Moon rocks have become available, but no answers are forthcoming. Although some old questions have been answered, even more new problems have arisen.

God teaches us something about our limitations through His prophet Isaiah:

For my thoughts are not your thoughts, neither are your ways my ways, declares the LORD. As the heavens are higher than the earth, so are my ways higher than your ways and my thoughts than your thoughts (Isa. 55:8–9).

God reveals His thoughts in two ways: in the Bible, and in His creation. In spite of intensive research, no biologist, chemist, or engineer has yet been able to understand fully the brilliantly devised process of photosynthesis, not to mention the (im)possibility of imitating it. But the Creator has installed this wonderful ability in even the smallest blade of grass. We encounter fascinating frontiers in all kinds

of scientific endeavor here on earth. It is no surprise, then, that we are greatly challenged when it comes to investigating the universe. We do not know its structure nor its spatial relationships. Where are its boundaries if it is finite? Is the universe an open system or is it closed?

Can the vast distances be accounted for if the universe is “young”? According to the evolutionary view, the light of a star which is millions of light-years distant must have taken millions of years to reach us. This places a minimum on the age of the universe. All too often, vague theories, conjectures, or even plain speculations parade as certain knowledge. Steven Weinberg, who was awarded the Nobel Prize for physics in 1979, honestly concedes that he gets a feeling of unreality when he writes as if he really knew what it was about [W2, p. 18]. The well-known German astronomer Otto Heckmann says that a dense cloud hides the conditions prevailing when the cosmos was formed and those prevailing at its boundaries. Boundary conditions are observed on a backward-extending light cone that covers a finite range only. Observational data become progressively less accurate and eventually meaningless as distances increase, because of the limitations of our instruments [H2, p. 134]. Edwin Hubble (1889–1953) also emphasized the limits and uncertainty which characterize astronomical findings [L3, p. 181]:

Our deep space investigations end with a question mark. How could it be otherwise? We have some knowledge of our immediate neighbors, but our knowledge diminishes very rapidly as the distance increases. Eventually we reach the last frontier at the observational limits of our telescopes where only vague glimmers can be perceived. There we measure mere shadows, and amidst ghostly errors of spectral measurement we look for milestones which are hardly more real than ghosts or specters.

*Theme of this book:* Many fascinating facts about the stars, the galaxies, and the planets have become known by means of present-day

observational techniques. There are, however, astronomical questions that will never be resolved in spite of all our efforts, because the greatness of the LORD who created everything cannot be fathomed (Ps. 145:3). Even His works are unfathomable. His works, which are studied in astronomy, are much less fathomable than those involving other sciences. For some questions, however, we do have answers as given in the Bible: Why do all the stars and the immense universe exist? Who created them? Whose ideas and purposes are implemented? Are we dealing with chance and necessity, or with a brilliant master plan? Is it possible to know the Creator personally? Answers to such questions are not found in astronomy books and journals, but it is exactly these questions that will be discussed in this book, because such questions concern us personally and answers may be found in the Bible, as we shall see.

*Aids to understanding:* Although not an astronomy textbook, this book includes many new discoveries of this quickly expanding science. Explanatory endnotes are provided when new concepts are mentioned for the first time. Other important terms are discussed more fully in the appendix (section A3). Such terms are indicated with an arrow (e.g., → celestial sphere). Most Bible references are quoted directly, to avoid having to look them up. Except where indicated, the *New International Version* has been used. References to apocryphal books have been taken from *The Jerusalem Bible* (London: Darton, Longman & Todd, 1966). When reference is made to the apocryphal "Ecclesiasticus" (not to be confused with "Ecclesiastes"), "Sira," the name of the author (abbreviation: Sir.) is used to avoid confusion.

*Readership and purpose of this book:* No specific educational level or age group has been targeted. Those works of creation studied in astronomy are so fascinating that everybody should be interested, regardless of profession or standing. Astronomical facts are correlated with biblical pronouncements. Very few books, if any, cover this aspect, and it is the sincere desire of the author that believers will acknowledge the greatness of God when contemplating the vastness of the universe and its stars. Wonder may then become worship. Another important



purpose is that the seeking or doubting person should find God and obtain assurance of salvation.

*A note of thanks:* The manuscript was scrutinized by Dr. Norbert Pailer (Meersburg, Germany), Andreas Wolff (Giessen, Germany), after in-depth discussions with my wife. I am grateful for all their suggestions and additions.



## INTRODUCTION

All of us must occasionally have wondered why there are stars in the sky. This book deals with this very question. Arguments and answers are based on numerous astronomical facts, as well as on the Bible. To my mind, scientific findings and biblical affirmations are inseparable. It is a tragic fact of history that these two approaches have diverged and become separated.

The well-known Psalm 19:1–6 provides a first answer:

The heavens declare the glory of God; the skies proclaim the work of his hands.

Day after day they pour forth speech; night after night they display knowledge.

There is no speech or language where their voice is not heard.

Their voice goes out into all the earth, their words to the ends of the world. In the heavens He has pitched a tent for the sun, which is like a bridegroom coming forth from his pavilion, like a champion rejoicing to run his course.

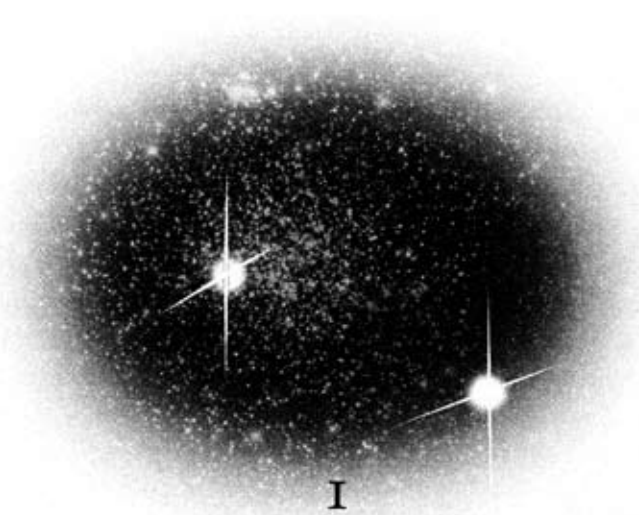


It rises at one end of the heavens and makes its circuit to the other; nothing is hidden from its heat.

The Hebrew word for heavens (v. 1) is *shamayim*, which has more than one meaning, as in English and in other languages. It can mean the earth's atmosphere (Gen. 1:20), or the starry heavens (Gen. 1:15), or the place where God dwells (Ps. 14:2). In every case, the context determines the meaning;<sup>1</sup> it is clear that Psalm 19 refers to the stars. This is a good place to start developing our subject. Various interesting and related topics are discussed in the following chapters, culminating in the last chapter where the purpose of this book is revealed and the questions are resolved. We will now respond to Jeremiah 51:10: "Come, let us tell . . . what the LORD our God has done."

#### Endnotes

1. Polysemy (Greek *polos* = many; *sema* = sign, *semantikos* = having significance): Linguistically, polysemy indicates ambiguity of a word. The context indicates the appropriate meaning.



I

## CAN THE STARS BE COUNTED?

People have always been fascinated by the stars, and many have tried to count them. When God promised Abraham that he would have innumerable descendants, He drew a striking comparison: “Look up at the heavens and count the stars — if indeed you can count them.” Then He said to him, “So shall your offspring be” (Gen. 15:5). Stars up to the sixth → magnitude<sup>1</sup> are visible to the naked eye. The total number of individual stars visible in both the northern and the southern → celestial hemispheres is about 6,000. On a clear night, one can thus see at most 3,000 stars at the same time. Is that it? With the advent of telescopes many previously unknown stars were discovered. Galileo (1564–1642) was probably the first person to do that, using his homemade telescope. In his famous work *Sidereus nuncius* (1610), he wrote:

It is really astounding to be able to add an innumerable number of fixed stars to the large number which we have been

aware of up to now. These others which have never before been seen, have now become visible and comprise a tenfold increase in the number of stars.

Galileo saw a tenfold increase in the number of visible stars, that is, up to 30,000. From 1852 to 1859, F.W. Årgelander completed his survey and counted 324,198 stars up to the 9th magnitude. The number of stars was once more increased by a factor of ten. The largest earth-bound telescopes, using photographic plates and long exposure times, have made three billion stars visible in each hemisphere (celestial hemisphere), most of which belong to the local Milky Way galaxy. Each half of the → celestial sphere comprises an area equal to 100,000 full moons as seen from earth. It follows that about 30,000 stars occupy an area equal to the full moon. The total number of stars which Galileo could see can today be observed in an area no larger than the apparent size of the moon! Is this the upper limit?

The local Milky Way galaxy has been found to contain 200 billion stars — what an astounding result! If somebody could count three stars per second, then, after 100 years, he would have counted only five percent of this number. Our galaxy comprises not only an unimaginable host of stars, but the size of this bright starry band in the sky is also astounding. Its diameter is said to be 100,000 light-years. Astronomical distances are too large to be measured in miles or kilometers, so light-years are used instead. One light-year is the distance that a light ray travels in one year. At a speed of 300,000 km per second, it amounts to 9.46 trillion kilometers. The total mass of all the stars in the Milky Way amounts to 200 billion times the mass of the sun, which is  $2 \times 10^{27}$  tons, or 333,000 times the mass of the earth. Can we really grasp these large masses and those immense sizes and distances?

And is this the only galaxy? No, with the naked eye we can see three more, namely the two Clouds of Magellan near the southern celestial pole, and the Andromeda galaxy in the constellation of the same name

(designated M31 in Messier's catalogue,<sup>2</sup> or NGC 224 in the *New General Catalogue of Nebulae and Clusters of Stars*). Andromeda was recognized as a galaxy consisting of individual stars as late as 1923, by means of the 2.5 m mirror telescope at Mt. Wilson. This galaxy is thought to be 2.25 million light-years from us.<sup>3</sup> Its total light emission is equal to 2,500 million times that of the sun. However, at this distance stars having the same luminosity as the sun can no longer be proved to exist by the use of optical telescopes. The Andromeda galaxy is the most distant object in the universe that can be seen by the naked eye, except for the occasional supernova.

Numerous other galaxies were discovered by means of the prolonged exposure of photographic plates. According to currently available data, there are 100 million galaxies with stellar magnitudes of up to 21. The actual number could be appreciably larger, because only galaxies up to apparent magnitude 23 lying within a distance of a few billion light-years can be observed. Furthermore, small galaxies are difficult to detect. Probably the world's best telescope is that of the European Organization for Astronomical Research (ESO), located in Chile. The faintest galaxies that can be detected on a photographic plate appear 1,600 million times less bright than stars that can just be seen by the naked eye. A glowing cigar on the moon will have the same apparent brightness on earth as the faintest observable galaxy. Attempts to count even the farthest and the faintest galaxies are continuing. To this end, charge coupled devices (CCDs) are directed at a particular spot in the sky for up to six hours. This process is repeated with different filters to obtain information about the colors of the light emitted by the galaxies. J.A. Tyson of Bell Laboratories and P. Seitzer of National Optical Observatories have succeeded in detecting galaxies up to stellar magnitude 27, covering between 70 and 80 percent of the area of the celestial sphere.

The total number of galaxies discovered thus far is probably in the region of several hundred billion, and it may even amount to a few trillion.

# STARS AND THEIR PURPOSE



“To my mind, scientific findings and biblical affirmations are inseparable. It is a tragic fact of history that these two approaches have diverged and become separated.” – From the Introduction

**D**id you know that there are 200 billion stars in our galaxy alone? And that according to current data, there are at least 100 million galaxies in existence? The sheer number of stars in the universe attests to the awesomeness of God’s creation. The purpose and features of stars are discussed in this exciting and fascinating book by Dr. Werner Gitt. Learn about topics such as:

- How are stars different from each other?
- How big is the universe?
- Why did God create the stars?
- Surprising facts about the sun and moon.
- How and when do solar eclipses happen?

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