# A HISTORY OF ASTRONOMY

A.PANNEKOEK

"...a carefully reasoned history of astronomy ... clearly the work of a man who loved his subject."—The Times (London) Literary Supplement

Few histories of astronomy offer the special human dimension of this book. For the late Professor Pannekoek (University of Amsterdam), the history of astronomy consisted in the growth of man's concept of his world. The study of the cosmos became an essential part of the history of human culture, an adventure of the mind.

In this well-balanced account of that adventure, the author is at pains to relate the development of astronomy to the social and cultural background in which it is nurtured. Thus, the effect of changes in political conditions, the influence of geography, the growth of industry and of communications methods are clearly and incisively described.

Dr. Pannekoek begins with an unusually detailed account of astronomy in ancient times, including Babylonian sky-lore, Assyrian astrology, the Ptolemaic worldview, Hellenistic astronomy, the epicycle theory, and Arabian astronomy. The growth of astronomy after Copernicus comprises the second part of the book, acquainting the reader with the epoch-making work of Kepler and Newton and the astonishing developments of celestial mechanics during the eighteenth century. Part III begins with Herschel, the gifted amateur whose observations opened up new horizons, and ends with Eddington's pioneering studies of the internal constitution of stars.

Comprehensive, well-written and full of small, revealing details that attest to the scope and depth of the author's learning, this splendid survey belongs in the library of every astronomer—or anyone interested in the grand mystery of the cosmos and man's attempts to penetrate it.

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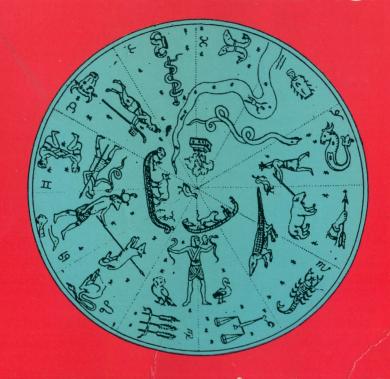
# ASTRONOMY

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### INTRODUCTION

STRONOMICAL science originated in a much earlier period of human history than the other natural sciences. In the remote past, when practical knowledge in daily life and work had not yet led to a systematic study of physics and chemistry, astronomy was already a highlydeveloped science. This antiquity determines the special place which astronomy has occupied in the history of human culture. The other realms of knowledge developed into sciences only in later centuries and this development took place mainly within the walls of universities and laboratories, where the noise of political and social strife seldom penetrated. Astronomy, on the contrary, had already manifested itself in the ancient world as a system of theoretical knowledge that enabled man to prophesy even the terrifying eclipses and had become a factor in his spiritual strife. What you not have not a saw of leave and

This history is associated with the process of the growth of mankind since the rise of civilization and, to a great extent, belongs to times in which society and the individual, labour and rite, science and religion, still formed undivided entities. In the ancient world and in the following centuries astronomical doctrine was an essential element in the world concepts, at once religious and philosophical, which reflected social life. When the modern physicist looks back at his earliest predecessors, he finds men like himself, with similar though more primitive views on experiment and conclusion, on cause and effect. When the astronomer looks back at his predecessors, he finds Babylonian priests and magicians, Greek philosophers, Mohammedan princes, medieval monks, Renaissance nobles and clerics—until in the scholars of the seventeenth century he meets with modern citizens of his own kind. To all these men astronomy was not a limited branch of specialist science but a world system interwoven with the whole of their concept of life. Not the traditional tasks of a professional guild but the deepest problems of humanity inspired their work.

The history of astronomy is the growth of man's concept of his world. He always instinctively felt that the heavens above were the source and essence of his life in a deeper sense than the earth beneath. Light and warmth came from heaven. There the sun and the other celestial luminaries described their orbits; there dwelt the gods who ruled over his destiny and wrote their messages in the stars. The heavens were near and the stars played their part in the life of man. The study of the stars was the unfolding of this higher world, the noblest object that human thinking and spiritual effort could find.

This study, continued through many centuries, and even in antiquity,

taught two things: the periodic recurrence of celestial phenomena and the vastness of the universe. Within the all-encompassing celestial sphere with its stars, the earth, though for man the centre and chief object, was only a small dark globe. Other world bodies—sun, moon and planets, some of them of larger size—circulated around her. This was the world concept which, when the ancient world collapsed and science fell into a depression lasting a thousand years, was kept as a heritage and at the end of the Middle Ages was transmitted to the rising West-European culture.

There, in the sixteenth century, driven by a strong social development, astronomy gave rise to a new concept of the world. It disclosed that what seemed the most certain knowledge of the foundation of our life—the immobility of the earth—was merely an appearance. It showed moreover, that our earth was only one of several similar planets, all revolving about the sun. Beyond was endless space with the stars as other suns. It was a revolution, opening new ways of thinking. With hard effort and much strife mankind had to reorientate itself in its world. In those centuries of revolution the contest over astronomical truth was an important element in the spiritual struggle accompanying the great social upheavals.

Astronomy, like the study of nature in general, now entered a new era. The next century brought the discovery of the fundamental law controlling all motions in the universe. Philosophical thinking was for the first time confronted with an exact and strict law of nature. The old mystical, astrological connection between the heavenly bodies and man was replaced by the all-pervading mechanical action of gravitation.

Then, at last, in the modern age of science, the concept of the universe widened to ever larger dimensions, expressible only in numbers, against which to speak of the smallness of the earth is a meaningless phrase. Again—or still—astronomy is the science of the totality of the universe, though now merely in a spatial sense. Whereas in the ancient world the idea of the unity of the heavenly and the human worlds exalted the hearts of the students of nature, now men are stirred by the proud consciousness of the power of the human mind, which from our small dwelling place is able to reach up to the remotest stellar systems.

In early times, when physical theory was but abstract speculation, astronomy was already an ordered system of knowledge giving practical orientation in time and space. In later centuries, astronomical research was directed more and more towards theoretical knowledge of the structure of the universe, far beyond any practical application, to satisfy the craving for truth, i.e. for intellectual beauty. Then the mutual relation of the sciences became the opposite of what it had been before. Physics, chemistry, and biology shot up with increasing rapidity.

Through technical applications they revolutionized society and changed the aspect of the earth. In this revolution astronomy stood aside. The stars cannot contribute to our techniques, our material life, or our economic organization. So their study became more and more an idealistic pursuit tending toward a physical knowledge of the universe. While the other sciences won brilliant triumphs in a transformation of the human world, the study of astronomy became a work of culture, an adventure of the mind. Its history thus remains what it has always been, an essential part in the history of human culture.

Whoever penetrates into the past participates in the development of the human race as his own experience. It is the aim of this work to unfold in this past the development of our astronomical world concept as a manifestation of humanity's growth.