UNIVERSITY OF GLASGOW

University Library

and

Department of the History of Science.

NICOLAUS COPERNICUS

1473 - 1543

Feb. 19th May 24th.

A COMMEMORATIVE EXHIBITION.

February - April 1973

Peter Isaacson

to the University Library, Turku,

September 1973

INTRODUCTION

Nicolaus Copernicus was born in the Polish city of Torun on February 19th, 1473. Torun was a thriving merchant town in the Hanseatic league, at the centre of a network of roads and trading by sea widely over Northern Europe. The Copernicus family were prosperous traders, and there is no doubt that young Nicolaus must have met a wide range of travellers, both Polish and foreigners. The city itself was a lively place, as is shown by the number of buildings erected in the 15th century and which still survive. There were two towns within the city, the "old" or trading town on the banks of the Vistula and the "new" or craft town a little way back. There was a stout wall between the two cities which were administered as separate entities until 1454, and the whole was under the surveillance of a castle of the Teutonic, or German, Knights. Not long before Copernicus' birth, in 1466, peace was made at Torun between the Poles and the Teutonic Knights. By Copernicus' youth the political situation had quietened down, but there was probably still an air of tension within the city between the two communities.

Nicolaus received his earliest education in Torun, but in 1491 he entered the Jagellonian University of Cracow. The University,

founded in 1364, had already achieved considerable intellectual standing and it seems likely that it was here under the influence of Brudzewski that Copernicus' interest in astronomy was first roused. Like many bright young men of his time, he travelled from his homeland to Italy where he studied at several Universities including Bologna, Padua and Ferrara. His stay in Italy was interrupted by a visit to Poland, during which he was instituted to a Canonry of the Cathedral of Frombork in the diocese of Ermland of which his uncle was Bishop.

When Copernicus took up his Canonry in 1503, it was as an ecclesiastical administrator rather than as a Minister of the Gospel, for he never entered priests' orders. His interests were wide-ranging for he wrote a certain amount of indifferent poetry, practised medicine, and, since he was a Doctor of Canon Law of Ferrara, we can imagine that he was competent on the legal side of his administrative duties. Nevertheless, it seems very likely that his astronomical interests occupied most of his leisure time.

The earliest of his astronomical writings which survives circulated in manuscript, but was not printed until the last century. This most revealing document, known as the Commentariolus, was probably written in about 1510, and gives a concise and clear account of his new astronomical system. His reputation as an astronomical speculator must have been fairly well established amongst the professional astronomers, as is shown by the invitation extended to him to give his opinion on the reform of the Calendar to the Lateran Council in 1514. However, he does not seem to have been anxious to publish a full account of his new system. In 1539 George Joachim

Rheticus, a young protestant scholar visited the catholic Copernicus in Frombork in order to learn from him the nature of the new system. Rheticus' account, the Narratio Prima, makes it clear that Copernicus already had completed his major work. Encouraged by Rheticus, Copernicus agreed to the publication of his De Revolutionibus, which was printed in Nuremburg and of which the first copies are said to have reached Copernicus on the day of his death, May 24th, 1543.

It is not very clear why Copernicus hesitated to publish his book: it seems unlikely that it was entirely through fear of ecclesiastical censure, since it contains a dedication to the Pope and an approving letter from a Cardinal. Copernicus was a mild, shy man and he may have been afraid of ridicule from his astronomical brethren. Furthermore, it is improbable that suitable printing facilities existed in parts of Poland which were readily accessible to him, and therefore mere technical difficulties may have caused him to delay until Rheticus appeared and was able to act as his messenger.

At the time of Copernicus, interest in astronomy was widespread and growing in Europe. This was indeed a time of general intellectual development, as is emphasised by recalling the invention of printing in about 1440 and the establishment of many universities, including ours, in the 15th century. But astronomical theory could be seen to be unsatisfactory, since discrepancies existed between the calendar as computed from astronomical data, and the seasons as observed by the farmer. Hence, indeed, the interest of the Lateran Council mentioned above.

The technical astronomy of the time was that of Ptolemy, which in turn was based on earlier Greek speculations with roots in the notions of the Ionian and Pythagorean thinkers. The essence of the theory was that all motions should be based on uniform circular motions, with the earth securely in the middle of the system. Unfortunately, hard observational fact made it impossible to employ merely simple uniform circular motions with the earth as centre, and the devices of the epicycle and the equant had had to be introduced. With the aid of these devices Ptolemy had developed a remarkably complete account of the visible motions which had considerable predictive accuracy - as is shown by the fact that his system remained the accepted one from about A.D. 120 until the time of Copernicus. Copernicus had strong objections to the theory:

"The planetary theories of Ptolemy and most other astronomers, although consistent with the numerical data, seemed likewise to present no small difficulty. For these theories were not adequate unless certain equants were also conceived; it then appeared that a

planet moved with uniform velocity neither on its deferent nor about the centre of its epicycle. Hence a system of this sort seemed neither sufficiently absolute nor sufficiently pleasing to the mind.

"Having become aware of these defects, I often considered whether there could perhaps be found a more reasonable arrangement of circles, from which every apparent inequality would be derived and in which everything would move uniformly about its proper centre, as the rule of absolute motion requires. After I had addressed myself to this very difficult and almost insoluble problem, the suggestion at length came to me how it could be solved with fewer and much simpler constructions than were formerly used, if some assumptions (which are called axioms) were granted me."

It can be seen quite clearly from these statements that Copernicus did not see himself as a revolutionary but as a reformer. He wanted to get rid of the intellectually unsatisfactory equants which had crept into the system and restore it to its primitive Pythagorean-Platonic purity of uniform circular motion. He claims in this passage that his system is simpler than the old one, but the number of circles actually needed is much the same in a Ptolemaic and a Copernican system to achieve the same degree of predictive accuracy. The only genuine simplification seems to be in the elimination of equants.

The "De Revolutionibus" itself is divided into six books or sections. The first of these is an elementary exposition of the new system, not worked out in any detail. Included is the well known

diagram consisting of a set of nine circles centred on the sun. All too often it has been assumed that this diagram represents the complete Copernican scheme, but it is really only a crude general sketch. In the later parts of the work Copernicus develops his system in great detail, with extensive tables of stellar and planetary positions and calculations of sizes of deferents and epicyclic circles and rates of motion. One important feature which is not made clear in the elementary introduction is that the most important geometrical point is the centre of the circular orbit of the Earth. The Sun plays a lesser role than this geometrical point, and rather stands by illuminating the system than determining the details of the motions. It is thus not entirely correct to describe the Copernican model as heliocentric.

The whole approach of Copernicus was an old fashioned one: the mathematical style and the type of exposition used is more nearly akin to that of Archimedes than to that of Newton. In many ways, Copernicus can be regarded as the last exponent of the old astronomy rather than as the first exponent of the new.

It may then be asked why the Copernican astronomy is regarded as so very important. Four considerations arise. First, Copernicus provided a new view of the heavens which fitted the observational facts and which was of similar predictive value to the old system. He thus showed that the old system was not, at least from the astronomical view, absolutely essential. After Copernicus it was possible for astronomers to invent further systems. Second, the system of Copernicus demanded that the fixed stars should be at a very great

distance compared with the sizes of the biggest planetary orbit. This was not so in the Ptolemaic system, simply because the problem of stellar parallax did not arise with a fixed earth. Third, the new system stimulated further astronomical calculations, the production of new tables and also new precise observations. Fourth, the Copernican scheme puts the Earth amongst the planets, thus calling into question the whole of the medieval world view. If the Earth were a planet like Mars or Venus then it must surely be made of the same material. Thus, it became necessary to think again about the whole structure of the cosmos and the place of man within it.

CATALOGUE

The Background to Copernicus.

In this section we show a selection of Astronomical books printed in Copernicus' lifetime and before, to demonstrate the breadth of current astronomical knowledge and interest.

Books from Antiquity

1) AUTOLYCUS OF PITANE (fl. 300 B.C.)

DE ORTIBUS ET OCCASIBUS LIBRI DUO (1st printed ed.) 1501

BD9 - a.3

2) ARISTARCHOS OF SAMOS (c.310-230 B.C.)

DE MAGNITUDINIBUS ET DISTANTIIS SOLIS ET LUNAE 1572 (1st printed ed.1488?)

N7.21

3) THEON OF ALEXANDRIA (c.350 A.D.)

IN CLAUDII PTOLEMAEI ... COMMENTARIORUM (1st printed ed.) 1538

Bh.3 - d.15

4) C. PTOLEMY (fl. 150 A.D.)

INERRANTIUM STELLARUM SIGNIFICATIONES 1533 (1st ed.1516)

Bd.4.22

5) C. PTOLEMY (fl. 150 A.D.)

SYNTAXIS MATHEMATICA, commonly known as the ALMAGEST. (1st printed ed.) 1515

R.3.4.

6) MARTIANUS CAPELLA (fl. 470 A.D.)

DE NUPTIIS PHILOLOGIAE ET MERCURII 1532 (1st printed ed.1499)

Bn7 - b.12

Books from Antiquity (contd.)

7) C. J. HYGINUS (fl. 25 B.C.)

POETICON ASTRONOMICON 1485 (1st printed ed. 1475)

EPB 3 - 23i

Books from the Arabs or with strong Arabic influence

8) ALBUMASAR (c.810-886)

INTRODUCTORIUM IN ASTRONOMIAM (1st printed ed.)1489

BD7 - e.16

9) ALKABITIUS (d. 967)

ASTRONOMIE IUDICARIE PRINCIPIA TRACTANS 1506?

R.7.13

10) ALFONSO X, known as the Wise, King of Castile and Leon.

TABULAE ASTRONOMICA 1492 (1st printed ed. 1483)

EPB3 - 97a

The Introduction of Detailed Ptolemaic Astronomy

11) G. PEURBACH (1423-1461)

THEORICAE NOVAE PLANETARUM 1543 (1st ed. 1473)

R.6.1.

12) G. PEURBACH and J. REGIOMONTANUS

EPYTOMA IN ALMAGESTUM PTOLEMAEI (1st ed.) 1496

By.2.21

The Textbooks/

/The Textbooks

13) JOHN OF HOLYWOOD OR SACROBOSCO (fl. 1200-1250)

SPHAERA MUNDI 1478 (1st printed ed. 1472)

EPB3 -152a

14) GIOVANNI CAMPANO (c.1260-1292)

TRACTATUS DE SPHAERA (1st printed ed.) 1518

Ai - x.9

15) FRANCESCO MAUROLICO (1494-1575)

COSMOGRAPHIA (1st ed.) 1543

Cn 2.28

New Views on Astronomy

16) G. FRANCASTORO (1483-1553)

HOMOCENTRICA (1st ed.) 1538

BC5 - c.15

17) C. CALCAGNINI (1479-1541)

QUOD CAELUM STET, ... (1st ed.) 1544

Bh8 - d.1.

Calenders

18) J. REGIOMONTANUS (1436-1476)

KALENDARIUM 1482

BD7.f.13

19) J. STÖFFLER

CALENDARIUM ROMANUM 1518-1579 1518?

Bl.4.d12

"De Revolutionibus Orbium Coelestium"

The University posseses three copies of the first edition of the De Revolutionibus, three of the third edition and one each of the fourth and fifth. The most recent Copernican acquisition is a newly published facsimile of the original manuscript.

20) 1st edition 1543

Cz 1.13

21) 1st edition 1543

Bk 2 - e.5

22) 1st edition 1543

Ea 6 - a.3

23) 3rd edition 1617

Bal - e.19

24) 4th edition 1854

I5 - x5

25) 5th edition 1873

I5 - x6

26) Facsimile 1973

The Development of Copernican Astronomy

In this section we show, through the work of his successor, how the Copernican ideas affected the progress of astronomy, immediately by the production of new astronomical tables and then by stimulating great observer Tycho Brahe, whose results in turn provided the data essential to the theoretical work of Johann Kepler.

The Prutenic Tables

27) ERASMUS REINHOLD

PRUTENICAE TABULAE COELESTIUM MOTUUM. 1562 (1st edition 1551)

Bm4 - h.2.

Tycho Brahe (1546-1601)

28) EPISTOLARUM ASTRONOMICARUM. 1610
R.5.17

29) ASTRONOMIAE INSTAURATE PROGYMNASMATA. 1648
Ea6 - c.6.

30) DE MUNDI AETHERI..... 1610
R.5.18

31) ASTRONOMIAE INSTAURATAE MECHANICA 1602
Ea8 - x.15

Johann Kepler (1571-1630)

32) MYSTERIUM COSMOGRAPHICUM 1621
R.3.6.

33) ASTRONOMIA NOVA (1st edition) 1609
Bk10 - c.10

34) HARMONICES MUNDI (1st edition) 1619
B18 - d.5.

35) TABULAE RUDOLPHINAE (1st edition) 1627
two copies Ea6 - x.15
Aw 1.12

36) AD VITELLIONEM -- ASTRONOMIAE PARS OPTICA. 1604
R6.13

37) EPITOME ASTRONOMIAE COPERNICANAE 1622
Bi1 - 1.5.

Johann Kepler (Contd.)

38) DIOPTRICE 1611

Ea7 - c.25

39) CHILIAS LOGARITHMORUM... 1624

Ea5 - d.19

Miscellaneous Works

Here we have included a range of books to show the breadth of interest in astronomical matters.

Books in English

40) GEOFFREY CHAUCER (1340?-1400)

TREATISE ON THE ASTROLABE (1st printed ed.) 1532

Bs 2.17

41) ANTHONY ASKHAM

A LITELL TREATISE OF ASTRONOMY 155•

Au - 4 - 11(h)

42) WILLIAM BOURNE

A BOOKE CALLED THE TREASURE FOR TRAVEILERS 157•

BD1 - d.34

43) THOMAS HILL

THE SCHOOLE OF SKIL 1599

Ag - d.17

Astrology

44) GUIDO BONATTI (1230-1296)

DECEM TRACTATUS ASTRONOMIAE (1st printed ed.) 1491

BD9 - e.12

Astrology (Contd.)

45) JOHANN ENGEL (1463-1512)

ASTROLABIUM PLANUM (1st edition) 1488

SM.104

Astronomy and Theology

46) CARDINAL PETRUS DE ALLIACO (1350-1420)

CONCORDANTIA ASTRONOMIE CUM THEOLOGIAE (1st edition) 1490

Bx3 - 41^2

Two Unique Volumes

47) GEORGE BUCHANAN (1506-1582)

SPHAERA MUNDI 1585

Mu50 - e.33

48) WILLIAM OF CONCHES (b.1080)

DIALOGUS DE MUNDO Manuscript of 13-14 century.

V.5.14