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J. R. Ravetz

THE CYCLE OF SCIENTIFIC ACHIEVEMENT

Science is a social activity, and we will be able to write its history only when we can describe the interaction of a scientist's life work with the activities of the scientific community, and also the relations of the scientific community with society at large. In order to provide categories for describing these interactions, I have sketched a cycle of scientific achievement, which I illustrate by the example of the career of Copernicus.

We set the stage with social and philosophical background, interpreted through biography of the individual. In this case, we cite the progressive conditions in fifteenth-century Poland, the excellence of the Jagellonian University at Cracow, and Copernicus's family connections with the bourgeoisie, the Church, and with Humanist culture. Next comes the internal scientific tradition, and the condition and problems of the relevant science at the time. For this we have the re-creation of astronomical science, above the existing level of semi-competent technique, by Peurbach and Regiomontanus. Also, we notice the development of other elements of the structure of a fully developed scientific community, in particular the establishment of a teaching tradition at a few places including Cracow.

Now we reconstruct the problem-situation seen by Copernicus, and his initial insights. I believe that the key problems were those of fundamental reference-frames of observational astronomy (definition of the year, interpretation of changes in stellar longitudes), and the basic physical structure of the heavens. Investigation of these two problems could lead to a conviction of the earth's diurnal rotation and annual revolution as necessary facts for a coherent science of the heavens.

Following this brief and intensive phase comes a long period of consolidation, sustained by the personal identification of the scholar with his discovery. The *Commentariolus* dates from very early in this phase, perhaps even before Copernicus left Cracow. In Italy Copernicus

could master the advanced astronomical technique, and the classical sources, necessary for a solid foundation to a complete new system of astronomy. In the later period of consolidation comes the struggle with "contradictions" — problems too deep to be solved by ordinary technical means. The contradictions of "theory and practice" appear in the case of Copernicus as the failure of successive sets of information to stabilise, so that up to the very end he was forced to revise the fundamental parameters in a system which he had hoped would be valid for centuries to come. More serious are the "internal" contradictions; in this case, the failure of his developed astronomical system to provide conclusive proof of the truth of his initial insight of the motions of the earth.

Out of this comes the mature achievement, whose content necessarily reflects the struggles of the phase of consolidation more than the simple insights of the first heroic period. The structure and content of the *De Revolutionibus* are significantly different from those of the *Almagest*; this comes partly from an organisation of the problems Ptolemy chose to ignore but which became pressing in the Medieval period, and partly from refinements discovered by Copernicus himself.

We conclude the cycle with a discussion of the successes and failures of the endeavours of the scholar, and with an analysis of his "style of work". Finally we study the new traditions coming out of the work. We keep in mind the changes in the condition of the science during the life of our object, and the further changes which make later generations see the work in terms of their own situation and problems.

Through such an analysis, we can show how several supposed "paradoxes" in the work of Copernicus arise from attempts to describe a complex historical process as a single event.