

review of the application of fibers for reinforcing, insulation, fillers, and as fabrics, tapes, and paper; a very general approach is used but some specific examples are given.

The next chapter on factors affecting strength is perhaps the most disappointing in organization and emphasis. The pertinent factors are discussed in terms of the specific types of materials (i.e. glass, ceramic, and graphite) but within each section the intrinsic, fabrication, and environmental effects are liberally mixed compounding an already complex situation. For this chapter there is a relatively heavy emphasis on glass and fused-silica fibers which was not expected from the book title. As a parting thought the chapter closes with an incomplete section on testing and evaluation.

Sandwiched between the three most relevant chapters on organizations interested in fibrous materials, the patent abstracts, and the bibliography are two short chapters. These concern: (1) Evaluation and Discussion and (2) Conclusions and Recommendations. They contain all too general and obvious statements (e.g. Recommendation 1: "That the interested reader continue to seek the latest informa-

tion in the patent and technical literature.") that could just as well have been included as summary statements at the end of previous chapters or left out altogether.

Other annoying elements present are obvious editorial mistakes such as misprinted symbols, typographical (spelling and numerical) errors, improperly labelled figures and tables (e.g. Tables I, XX, XXI and XXII list the units of stress and the elastic modulus as $10^{-3} \times \text{psi}$ and $10^{-6} \times \text{psi}$ respectively). These might be tolerated in reports, but definitely should not appear in book form.

In summary this book can serve some useful purpose currently since the organization reports, patent abstracts, summary tables, and cross-referenced subject and author indices will provide a useful source of information. It appears however that most of the other chapters (except chapter 3) were used as dressing and filler material containing brief generalizations that are the domain of review articles and reports already in print.

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He left his imprint

HOMAGE TO GALILEO. Conf. proc. (Rochester, Oct. 1964). Morton F. Kaplon, ed. 139 pp. MIT Press, Cambridge, Mass., 1965. \$6.00

by *L. Marton*

There were many celebrations in 1964, commemorating the 400th anniversary of Galileo's birth. Some appeared in print, like the one reviewed here, others not. Many opinions were voiced about Galileo's achievements, some of them contradictory. Galileo remains a controversial figure, which is by no means a derogatory remark. In fact, I believe that the controversies add to his stature and that we learn to appreciate more the versatility of his genius.

The present slim volume contains six contributions preceded by an introduction by Morton F. Kaplon. The

contributors are Giorgio de Santillana (professor of history and philosophy of science, MIT); Gilberto Bernardini (director, Scuola Normale of Pisa); Norwood Russell Hanson (professor of philosophy, Yale); Edward W. Strong (professor of philosophy, Berkeley); Philip H. Abelson (editor of *Science* and director, Geophysical Laboratory, Carnegie Institution of Washington); and Erich Kahler (formerly professor, Institute for Advanced Study, Princeton). The general tendencies in all papers are to extoll the achievements of Galileo, perhaps even beyond what may be called an objective presentation. This remark needs some clarification, which I would like to illustrate using a few examples.

Most people interested in Galileo are familiar with de Santillana's book

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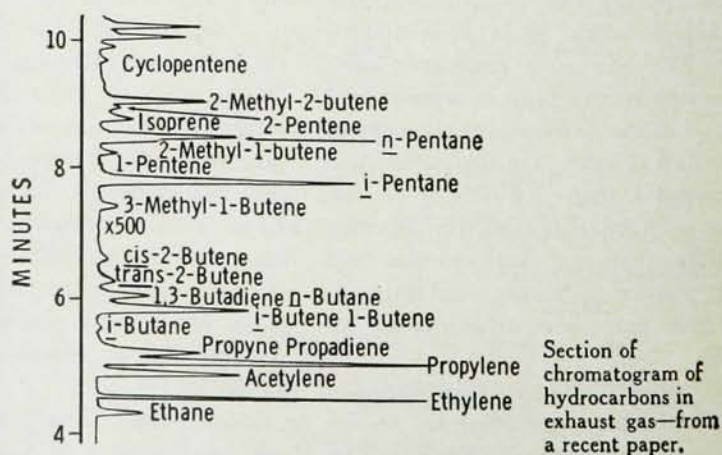
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GALILEO before the Inquisition

entitled, *The Crime of Galileo* as well as A. Koestler's book entitled, *The Sleepwalkers*. Both books deal with the life of our hero, but from very different viewpoints. While de Santillana has a strong sympathy toward the personality of Galileo, Koestler is strongly opposed to Galileo. The contrasting presentations are interesting reading. The same event, appearing in a favorable light in one book, may take an odious character in the other. My own reaction was to believe that the truth must lie in between. Galileo can not be as bad as Koestler wants us to believe, but de Santillana's praise may be a trifle overdone.

Having read both books some time ago, I have to admit to some bias in reading the present book. It starts with de Santillana's contribution entitled, "Galileo in the Present." Generally speaking, I liked it even better than his earlier book. I say generally speaking—I do not agree with every statement. For instance: on page 3 he says: "The thought of a sphere turning on itself in a void with no reason to stop—a typical gedanken experiment—gives him the idea of inertia." Likewise on page 4 he speaks of "the new concepts of Galilean *relativity*, *inertial mass*, *momentum*, *instant velocity*, *acceleration*." (Italics his!)

Pierre Duhem starts his monumental *Le Systeme du Monde* with the following statement: "In the genesis of a scientific doctrine there is no absolute beginning; as far as one may go back along the lineage of thoughts which have prepared, suggested, announced that doctrine, one may always find opinions which in turn have been prepared, suggested, announced; and if one ceases to follow this chain of ideas which preceded each other, it is not because we found the initial link, but because the chain sinks too deep and disappears in the depths of

an unfathomable past" (my translation).

In appraising the accomplishments of our great scientists I do not believe that we do them a service in ascribing more to their achievements than necessary. Let us take for instance "inertia." Its notion was probably conceived by Jean Buridan¹ about 300 years earlier. More probable is the conception of the idea by William of Ockham.² De Santillana mentions Buridan on page 15 (strangely Jean Buridan becomes Pierre Buridan), but the prior concept does not emerge. Neither does it emerge that some of the conceptions of Galileo, for instance that of "impeto" were rather fuzzy. According to Duhem (a statement contested by Koyré), Galileo's "impeto" is equivalent to Buridan's "impetus," as well as Descartes' "quantité de mouvement." Whether we accept Duhem's statement or Koyré's, the fact that confusion exists is demonstrated by the best English translation of the *Dialogues Concerning Two New Sciences* by Crew and De Salvio, where the same word, "impeto" is variously translated as "impetus," "momentum" or even as "motion." Again according to Duhem it was Leibnitz who demonstrated and not Galileo, that the fuzzy conception of impetus deals with a quantity which is proportional to the square of the velocity, rather than the first power of the velocity, as it was believed until then.

The second paper, by Bernardini, entitled "Galileo's Influence on Modern Society" shows the same tendency to praise Galileo beyond his merits. On page 30 Bernardini says: "The principles of inertia and mechanical relativity uphold him as the 'Father of Physics'; the measurement of time and of the velocity of light recognize him as the 'first physicist.' . . . the principle of inertia . . . embodies one

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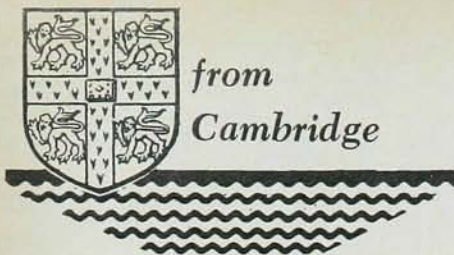
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of the greatest discoveries of science . . . it was formulated over and over again, and Descartes, Huygens and Newton expressed it in more precise and general forms. But Galileo's discovery differs from most of the others because it was reached by a solitary thinker, who . . . found the solution to a problem which had been haunting his unique mind for more than forty years."

On the same subject of inertia, Hanson writes in his contribution: "The idea of inertia, although imperfectly formulated by Galileo, was a great conceptual and theoretical achievement." On page 56 this statement is qualified: "If, however, we restate the law in its most transparent form, it will read as follows: If there were a particle free of unbalanced, external forces, then it would either remain absolutely at rest or would manifest uniform rectilinear motion ad infinitum."

I believe to have demonstrated sufficiently by the above quotations how different interpretations can be applied to some of Galileo's achievements. Buridan's conception of inertia, rephrased with hindsight, would sound just as impressive as Galileo's. I do not begrudge calling him the "Father of Physics," but to call him the creator of the idea of inertia is praising him beyond the necessary limits. (Koyré says quite emphatically: "Galileo did not formulate the principle of inertia.") So is the idea of ascribing to him the measurement of the velocity of light. He had a vague conception, but as he puts it himself: ". . . I have not been able to ascertain with certainty whether the appearance of the opposite light was instantaneous or not; but if not instantaneous, it is extraordinarily rapid." Bernardini's comments to this quotation and to the preceding description of a proposed experiment are: ". . . one finds everything that is desirable in a physicist: imagination in inventing experiments, skill, objective reporting of results, correct estimate of experimental errors."

I believe that Galileo does not need to be praised beyond limits. He had enough solid achievements to his credit to establish his fame without exaggerated claims. Many of these are

duly recorded and extolled in these otherwise excellent papers. To illustrate again by quotations, Hanson states at the beginning of his contribution: "Centuries of scholarship to the contrary notwithstanding, Galileo was not a great experimental scientist. He was no experimental scientist at all; not as we would know one. Nor was he a powerful theoretical thinker, surely not within technical mechanics. But he left a mathematical stamp on nature, the full imprint of which is still felt by physicists and natural philosophers."

If for nothing else I like this volume for this admirable summary. There are many other facets of Galileo's work that are brought out in the different papers. I have not mentioned yet Strong's chapter entitled "Galileo on Measurement," which discusses in detail the principles that guided Galileo in introducing quantitative considerations into the observation of nature. If I may use one more quotation, I would like to pick the following statement by Strong: "Galileo's fourteenth-century predecessors in physics were blind to the necessity of measuring concomitant variations in establishing and testing laws of motion. Galileo was not."

The remaining two chapters are Abelson's "Science and Government" and Kahler's "Science and History." Within the framework of the Galileo celebration they are more devoted to discussion of rather current events.

In spite of my disagreement with some of the statements I would like to recommend the book very warmly. All the contributors are outstanding scholars and although some of the writings of the past centuries can be interpreted in different ways, depending on personal bias, there are only a very few points in this excellent volume where a disagreement can arise.

The presentation of the book is very good and the price is reasonable.

1. *Le Systeme du Monde*, Vol. 8. By P. Duhem. p. 338 (1958).
2. *Science of Mechanics in the Middle Ages*. By M. Clagett. (University of Wisconsin Press, 1961).

* * *

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