

--- The Legacy of Galil eo ---

This year marks the 400 th. anniversary of either the birth or death of several outstanding individuals-- Michelangelo, Shakespeare, John Calvin, and Galileo. Having on other Sundays given some attention to the first three, it seems only right before the year slips away, to indicate something of the life and greatness of the last named. And not only right but also correctively interesting. For, although Galileo is commonly acknowledged to be one of the great figures in science, and is oftentimes thought to have been a martyr to science under the reactionary power of Roman Catholic opinion, the matter is far from being that obviously simple and falls into no such black and white category. About his greatness there is considerable misunderstanding, resting all too commonly on "discoveries he never made and on feats he never performed." Contrary to statements still being made in various outlines of science, he did not throw down weights from the leaning tower of Pisa; and he did not invent the telescope, not the microscope, not the thermometer, nor the pendulum clock; and he did not discover the law of inertia, nor the parallelogram of forces or motions, nor the sun spots; and he did not prove the truth of the Copernican system. And about his run-in with the Roman Catholic Church, there is again a considerable amount of misunderstanding. The whole matter resulted from a complex set of circumstances, and was almost as uncomfortable for the church as for him. In no literal meaning of the term was he made a martyr to science. He was not tortured by the Roman Inquisition, he was not cast into a dungeon, he was not put

to death. And there is no evidence that beneath his breath he uttered the famous words that posterity has bequeathed upon--<sup>him</sup> "Nevertheless, it does move."

Galileo was born at Pisa <sup>on Feb. 15,</sup> ~~in~~ 1564, the year in which Shakespeare ~~also~~ was born and Michelangelo died. He came from an old Florentine family. His father, somewhat impoverished, was a cloth merchant and an accomplished amateur musician, and a person of decidedly independent views. Young Galileo had his first formal education at the Monastery of Vallombrosa, near Florence. His father wanted him to become a merchant, but the boy showed an early academic interest and aptitude and thus was enrolled in the University of Pisa for the study of medicine and philosophy. Such subjects, however, did not greatly interest him, particularly philosophy as then taught, and his natural bent drew him to mathematics and mechanics. Among other things he was greatly concerned with the theory of motion, something that had not yet been adequately developed, and he quickly gave proof of his brilliance when in his second year in the University he discovered that a pendulum of a given length swings at a constant frequency regardless of amplitude.

Because of financial inadequacy, he was forced to leave the University without taking a degree. His father with four other children to support could not meet the cost of the relatively high fees, and although there were some scholarships available for poor students at the University, and Galileo had applied for one, he had been turned down. Whether he was turned down because of a

sense<sup>d</sup> unorthodoxy in his outlook, or because of a biting sarcasm that he many times showed, or because of some mixture of both, is a matter of conjecture. <sup>any</sup>how, he left the University and continued with his studies, on his own, at home. There his work in applied mechanics, and his dexterity in making mechanical instruments and gauges for experimental purposes, and his invention of a hydrostatic balance about which he wrote a treatise <sup>that was</sup> and circulated in manuscript, brought him to the attention of various scholars and some influential individuals. One of these, the Marchese del Monte recommended Galileo to the Marchese's brother in law, Cardinal del Monte, who in turn recommended him to Ferdinand de Medici, the ruling Duke of Tuscany, with the result that four years after having been refused a scholarship at the University of Pisa and having had to drop out without taking a degree, Galileo was appointed a lecturer in mathematics at that university. He remained there three years, a not particularly happy experience, since he ran into and enlarged antagonism among members of the faculty. In 1592, again through the intervention of his patron, del Monte, he was appointed to the vacant chair of mathematics at the ancient and famous University of Padua under the jurisdiction of the Venetian Republic.

There he remained for eighteen years, making a name for himself, as a lecturer, and through treatises circulated in manuscript on mechanics, spherical geometry, and fortifications. Involved in this was the laying of the foundations of modern dynamics, the science concerned with moving bodies. But most

of the result of such research, he was not to publish until near the end of his life. Meanwhile, Galileo had become more and more involved in the subject of astronomy, and it is with this aspect of his life that he is largely associated. And indeed it was to involve him in years of embroilment, out of which history has accorded him a fame that in some measure tends to be distorted and misplaced.

It was <sup>in</sup> no way out of place for Galileo to have an interest in the subject of astronomy. Scarcely anyone could be wholly indifferent to the apparent motion of the sun around the earth, and beyond that it was <sup>2</sup> required of Galileo as a professor of mathematics, to teach astronomy, along with geometry and such other subjects as military engineering and fortification. The problem for Galileo, as for anyone else involved in the subject, was that of wrestling with two opposing theories and with a third somewhat compromising alternative theory. The common, long established, and held by many to be the orthodox theory, was that resting upon apparent commonsense observation, namely that the ~~xxx~~ earth was the centre of the ~~xxxxx~~ universe, round which the sun and other heavenly bodies revolved. This theory, carrying the historical weight of Aristotle, and elaborated upon by Ptolemy, an Alexandrian astronomer of the second century .D. was very much taken for granted, and beyond that it seemed to fit in with the various accounts of scripture. <sup>of</sup> even more ancient origin, was the germ of another theory, stemming from the Pythagorean

school , which had flourished between the fifth and third centuries B.C. Suggested by this school was the view that the earth rotated on its own axis, and advanced by one member of this school, Aristarchus of Samos, was the thought that the earth in addition to its daily rotation upon its axis also made an annual revolution round the sun. Thus it was the sun, and not the earth, that was the centre and hub of the universe. And at the time of Galileo there was still another theory, a kind of compromise theory that had been set forth by the sixteenth century Danish astronomer Tycho Brahe, which allowed that the planets revolved round the sun, but that they and the sun revolved round the earth.

It was the theory associated with the name of Aristotle, and even more with the name of Ptolemy that had overwhelmingly prevailed. Still the suggested theory of the Pythagorians had not been wholly forgotten, and some twenty one years before Galileo was born, it was given pronounced, although complicated, expression by a Polish cleric best known by his latinized name of Copernicus. For years he had withheld publication of his treatise on the Revolutions of the Celestial Orbs, out of fear, as he himself said, of "being laughed at and hissed off the stage". It was not until the last year of his life that he allowed publication of the treatise, and the first printed copy of the work was handed to him on his death-bed. His fear had little if anything to do with apprehension of being condemned by his ecclesiastical superiors. Rather it stemmed

from the ridicule and attack that he expected might come from the academicians, and more particularly from those narrowly entrenched in the teaching of a particular theory of astronomy. According to Koestler in his extensive research in o the subject, many in the hierarchy of the Roman Catholic church at the time, and over ~~xxxx~~ a period of some eighty years, were not unsympathetic to scientific investigation and discovery, and it was some of these who actually urged, convinced, and aided Copernicus in the publication of his volume. Cardinal Schonberg, for instance, who occupied positions of special trust under three successive Popes wrote to Canon Copernicus saying that he had learned with great admiration about his "having created a new theory of the Universe according to which the Earth moves and the sun occupies the basic and central position". And he went on to say, "Therefore, learned man, without wishing to be inopportune, I beg you most emphatically to communicate your discovery to the learned world..." Under such urging Copernicus published the volume, and he had the Cardinal's letter printed as a preface to the book, and he dedicated the book to the Pope, Paul III.

The volume, published in 1543, and known over more than the next fifty year aroused relatively little interest. It was a difficult book, addressed as the title-page said "to mathematicians only", and what reaction it drew from the academic world was, as Copernicus had feared, mainly in the nature of scorn, ridicule, and hostility. There were some exceptions, however, among them being the German astronomer Kepler, and Galileo. Both accepted the Copernican

view as pointing the way to a more adequate cosmology. Yet Kepler openly acknowledged such acceptance long before Galileo. With Galileo, despite the fact that he had inwardly accepted the main outline of the Copernican system while still in his twenties, he nevertheless held his conviction secret, except in some limited correspondence, for a considerable number of years, and all through his lecturing on astronomy at the Universities of Pisa and Padua he taught the astronomy of Ptolemy and repudiated the earth's motion. Some explanation for this is perhaps to be found in the same kind of fear that had made Copernicus so reluctant to publish his views. At least it was the explanation offered by Galileo, himself, in a letter written to Kepler:

"I have not dared" he wrote "to bring my views into the public light, frightened by the fate of Copernicus himself, our teacher, who, though he acquired immortal fame with some ~~was~~ yet by an infinite number of others-- for such is the number of fools-- laughed at and hissed off the stage."

Galileo ~~had~~ exaggerated the situation as it had applied to Copernicus personally, ~~and~~ he could scarcely imagine what was to be the developing situation for himself.

The developing situation moved into gear rather innocently enough with the invention of the telescope. Galileo did not invent the telescope, the credit going perhaps to someone in Holland, or even to several individuals who inde-

pendently had developed an instrument based on a combination of two lenses. But Galileo hearing about such an instrument in 1609, built one of his own, and one with a much larger magnifying power, and then even more significantly he turned it on the skies, rather than just on terrestrial objects, and thereby allied it with mathematics in seeking to enlarge understanding of the nature of the universe. The next year he published his observations in a booklet called "The Star Messenger". Among other things, he described the mountainous configurations of the moon, the phases of Venus which like those of the moon and the earth must come by reflected light from the sun, the vastly greater number of stars than had yet been realized, and the planet Jupiter having four moons "never seen from the beginning of the world up to our own times." All such did not give conclusive proof that the Copernican system was correct. Such, with <sup>the</sup> still limited knowledge, might have been fitted into the compromise system of Tycho Brahe. But such did throw doubt upon, and even made untenable the Ptolemaic system. This was particularly true with regard to the four moons of Jupiter, which in their revolving round that body, decidedly upset the orthodox doctrine that the earth was the centre of the universe around which everything revolved; and likewise with the phases of Venus, which seemed to give decisive evidence that that planet revolved around the sun.

Unlike the volume by Copernicus, that by Galileo created a sensation. Not



only was it ~~written~~<sup>9</sup> in a readily readable ~~way~~<sup>mannel</sup>, but it s account of new discoveries about the universe excited people throughout all Europe, and became a subject of speculation and discussion far beyond the limits of just science itself. Almost over night Galileo's name burst into world fame. The Star Messenger was published in March 1610, and by September Galileo, on the basis of his sudden fame, had relinquished his teaching post at the University of Padua, and had taken up a new post with the Medicis of Florence, under the extravagant title of extraordinary Professor of the University of Pisa and Philosopher and First Mathematician to his Serenity the Grand Duke of Tuscany. The following spring he spent in Rome, and <sup>P.</sup>~~the~~ visit ther was a triumph.

Cardinal del Monte wrote in a letter: "If we were still living under the ancient republic of Rome, I verily believe that there would have been a column on the Capitol erected in Galileo's honour." A select academy, presided over by Prince Cesi, elected him a member and gave him a banquet. Pope Paul V received him in a long and friendly audience. <sup>P.</sup>AND the Jesuit Roman College, including its chief mathematician and its several astronomers, honored him with various ceremonies ~~xxxxxxx~~ which lasted a whole day.

Galileo, however, was also not without enemies and detractors-- those who were jealous of his sudden great rise to fame, and not least those Aristotelians at the Universities and elsewhere who had a vested interest in tradition and in the monopoly of learning. Of such he wrote:

".... So far as I can see, their education consisted in being nourished from infancy on the opinion that philosophizing is and can be nothing but to make a comprehensive survey of the texts of Aristotle, that from divers passages they may quickly collect and throw together a great number of solutions to any proposed problem. They wish never to raise their eyes from those pages-- as if this great book of the universe had been written by nobody but Aristotle, and his eyes had been destined to see for all posterity."

There were various attempts made to discredit and to repudiate Galileo on scientific grounds, but this proving rather impossible-- even Jesuit astronomers finding supportive evidence for many of his observations-- the attack was shifted from science to Scripture and theology. Thus, for instance, there was quoted from Scripture that Joshua, after defeating the Philistines, had cried "Sun, stand thou still", which was said to clearly prove that it was the sun which moved, and not the earth.

Galileo, in a letter, enlarged upon later, and widely circulated argued that divinely revealed truth and the truths of nature cannot be contradictory, that in the case of seeming conflict between the two there should always be room for figurative rather than literal interpretation of the Bible, and he went on to propose that the Church should reevaluate such texts from Scripture as seemed to contradict what he ~~xxx~~ took for granted as being the truth of the

Copernican theory, and he insisted that the church must either endorse the Copernican theory or condemn it altogether.

It was a call for a showdown that some of Galileo's friends in the higher ranks of the Church hierarchy hoped might be avoided. Thus Cardinal Bellarmine General of the Jesuit Order and Consultor to the Holy Office suggested what was hoped to be an acceptable adjustment between science and faith. In a letter to a Carmelite monk who had just published a book advocating the Copernican system, but equally addressed to Galileo who is mentioned by name Bellarmine said that to teach the Copernican system as a working hypothesis superior to Ptolemy's "is to speak with excellent sense and to run no risk whatever. Such a manner of speaking suffices for a mathematician." But to speak of it as an established truth "is a very dangerous attitude and one calculated not only to arouse the scholastic philosophers and theologians, but also to injure our holy faith by contradicting the Scriptures." However, he continued, if there existed a real proof which truly demonstrates the earth's motion, then the relevant passages in the Scriptures would have to be reinterpreted. But, he concluded, I do not think there is any such proof since none has been shown to me."

For Galileo, however, this was not acceptable. The Copernican system must be right. Thus in 1616, he was in Rome, seeking unsuccessfully for an audience with Pope Paul V, and submitting what he held to be conclusive proof of the earth's motion. The proof had to do with the theory of the tides. Unfortu-

nately Galileo's presentation was ridiculous, although that might not have  
 made any difference. Ignoring Kepler's correct explanation of the tides as  
 an effect of the moon's attraction, and contradicting his own researches into  
 motion, he declared that the tides were a direct consequence of the earth's  
 combined motions which cause the sea to move at a different speed from the  
 land. His effort at a showdown ~~xxxxxx~~ in support of the Copernican theory  
 failed. On March 5, 1616, the Holy Office issued a decree in which "the  
 Pythagorean doctrine of the motion of the earth" was declared to be false and  
 altogether opposed to Holy Scripture; and the book of Copernicus was to be  
 suspended until corrected; ~~xxxxxx~~ and Galileo was ordered not to hold or defend the  
 Copernican doctrine. Still there was a considerable degree of leniency and  
~~xxxxxx~~  
 regard shown to Galileo. His name was not mentioned in the decree, his works  
 were not prohibited, and the injunction not to hold or defend the Copernican  
 doctrine was communicated to him privately, and a week after publication of  
 the decree, the Pope received Galileo in a long audience.

For some eight years Galileo remained silent on the matter of defending the  
 Copernican system. In 1623, his old friend and one of his greatest  
 admirers, Cardinal Barberini was elected Pope. He had opposed the decree of  
 1616; he had written an ode in honour of Galileo; and after he was installed  
 as Pope Urban VIII, he gave Galileo six long audiences in six weeks, and  
 showered gifts and favours on him. While the Pope could not revoke the  
 decree of 1616, he nevertheless allowed Galileo to depart for Florence with

papal permission to expound the Copernican system, provided he followed certain rules, such as to avoid theological arguments, and to speak of the earth's motion as a convenient working hypothesis without asserting that it was actually true, and ~~xxxxxxx~~ <sup>he</sup> ~~the Pope~~ gave as a warning argument that God's power was boundless, that therefore there was no limiting necessity for Him to have created the universe with the sun at the center since "he could have created ~~the~~ universe however He saw fit.

The next few years, Galileo spent in writing his "Dialogue on the Two Chief World Systems" in which he presented the case for and against the Ptolemaic and the Copernican systems through the mouths of three discussants. The work was printed in 1632. The volume however was seized upon as being in violation of the rules laid down by Pope Urban the VIIIth. Certainly the argument was far less hypothetical than the Pope had demanded, and beyond that Galileo had ended the work by placing the Pope's warning argument about God's power to have created the universe however he saw <sup>fit</sup>, in the mouth of Simplicio, the simpleton of the Dialogue, <sup>which</sup> made it seem like to personal insult of the Pope.

The result was that Galileo was summoned to appear before the Roman Inquisition. Summoned in October of 1632, he pleaded illness, and did not arrive until February. He was treated with <sup>considerable</sup> ~~all the~~ lenience and regard ~~due to the~~ foremost scholar of his time, comfortably housed, ~~and~~ never put in prison and

never tortured. And yet, with all this, he who had been so eager for combat with those who would deny or circumvent the new truths, made only feeble verbal resistance, and upon repeated examination, finally recanted, saying:

"I Galileo Galilei, son of the late Vincenzo Galilei of Florence, aged 70 years, being brought personally to judgement and kneeling before you, Most Eminent and Most Reverence Lords Cardinals, General Inquisitors of the Universal Christian Commonwealth against heretical depravity, having before my eyes the Holy Gospels which I touch with my own hands, swear that I have always believed, and, with the help of God, will in future believe every article which the Holy Catholic and Apostolic Church of Rome holds, teaches, and preaches. But because I have been enjoined, by this Holy Office, altogether to abandon the false opinion which maintains that the Sun is the center and immovable, and forbidden to hold, defend or teach, the said false doctrine in any manner... I abjure, curse and detest the said errors and heresies....."

Just how deeply these words were taken to go, either by Galileo himself or by his accusers, may be wondered at. But at least he had been humiliated, and the Church had again for a time saved theological face.

Galileo spent the year following his trial writing what is generally regarded to be his greatest and most significant book, called "Discourse and Demonstrations Concerning Two New Sciences". This picked up from and was

a continuation ~~from~~ what had been some of his earliest studies in the science of dynamics. Among other things he was able to explain that on a moving earth most phenomena- and all those we commonly observe- occur just as they would on an earth standing still. His findings were the beginning of what we today call inertial physics, the science that reached its culmination in the work of Sir Isaac Newton, who was born on Christmas Day in the year of Galileo's death, 1642. And he also analyzed the behavior of objects in motion, which led to the ~~to the~~ first two laws of motion, the foundation stones of Newton's Principia and the basis of all dynamics. With no hope of getting an imprimatur for the book to be published in Italy, the manuscript was smuggled out to Holland where it was printed.

In the following year Galileo went blind, first in one eye and then in the other. "Alas" he wrote to a friend "your friend and servant, Galileo has been for the last month hopelessly blind; so that this heaven, this earth, this universe, which I by marvelous discoveries and clear demonstrations have enlarged a hundred thousand times beyond the belief of the wise men of bygone ages, henceforward for me is shrunk into such small space as is filled by my own bodily sensations."

Yet he kept on dictating additional chapters to be added to the Two New Sciences, and received a stream of distinguished visitors, among them Milton who along with many others in England had been much impressed with Galileo's

opening of new vistas upon the nature of the universe. He died at the age of 78, still under house arrest since the time of his trial, but under very free house arrest that had never been made burdensome. His body was buried in the Pantheon of the Florentines, the Church of Santa Croce, next to the remains of Michelangelo and Machiavelli. When his friends wanted to erect a monument over his grave, Pope Urban told the Tuscan Ambassador that this would be a bad example for the world, since the dead man 'had altogether given rise to the great scandal throughout Christendom'.

The scandal, however, is that is what it may be called rests not with Galileo-- impetuous, vain, as he was and somewhat less than a towering moral hero. Rather it rests with those both within and outside the church, who could not and would not allow for freedom of thought and investigation and for its open expression. It is only a little more than a century ago that Galileo's "Dialogue on the Two Chief World Systems" was removed from the Index of the Roman Catholic Church. If in the end Galileo has been somewhat vindicated in his strife, his life and his abjuration still remain as poignant reminders that the free expression of truth may never be taken for granted.



ORDER OF SERVICE

December 6, 1964

Opening Music

Opening Words \* by Blaise Pascal, 17th Century  
French Philosopher

Hymn No. 64 "From the First Man to Climb  
the Hill"

Reading \* from "The Sleepwalkers"  
by Arthur Koestler

Interlude

Aspiration

Chorus: Sayings from "The People, Yes"  
by Carl Sandburg  
Composer - Raephling

Hymn No. 53 "Unrest"

Offertory \*

Address: THE LEGACY OF GALILEO Mr. Storm  
(400th Anniversary of Birth)

Hymn No. 69 "Affirmation"

Closing Words

Closing Music

Thomas Nee, Music Director  
Sylvania Palmore, Organist

\*Late comers may be seated

ANNOUNCEMENTS

Today 12:00 Coffee Hour  
7:30 Channing Club - Lower Auditorium  
Monday 7:30 Orchestra Rehearsal  
Tuesday 7:00 Philosophy Group - Library  
Wednesday 7:30 Chorus Rehearsal  
Thursday 6:00 POT LUCK DINNER  
Friday 8:00 Single Adults Club

NEXT WEEK

Address: "Small Church--Big Church" Mr. Hultberg

Forum: "Which Way America--Multilateral Dis-  
armament or Multilateral Force (MLF)"

Speaker: Mrs. Vienna Hendrickson

Music: Sylvia Palmore will play an organ solo.

Some of the quotations from the Chorus' song are:  
The cauliflower is a cabbage with a college education.  
Put all your eggs in one basket and watch that basket.  
Handle with care women, and glass.  
Blessed are they who expect nothing for they shall not  
be disappointed.

You can send a boy to college but you can't make him  
think.

The man put green spectacles on his cow and fed her  
sawdust.

The yes man spent his vacation yelling no no no I  
tell you.

A woman and a melon are not to be known by their  
outsides.

No matter how important you are, you may get the  
measles.

NOW READ THIS:

The Annual Budget Meeting will be held the 10th of  
December, preceded by a reception at 5:30 honoring  
recent new members to the Society and followed by a  
Pot Luck Dinner. Your attendance and advice are soli-  
cited for this very important function. It is here,  
more than at any other time, that the effectiveness  
of the Society can be evaluated and preparation made  
for our future. TO FACILITATE CLEAN UP AT THIS  
DINNER, WOULD EVERYONE PLEASE BRING HIS OWN PLATE,  
CUP AND SILVERWARE.