

A Brief History of Science

Part 3: The Dark Age

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The decline of science

We have seen in the last part that after the death of Alexander there was a vacuum in Greek leadership, and a civil-war like situation prevailed in the mainland Greece. The centre of intellectual activity shifted to the Egyptian port of Alexandria, but no military power emerged there either. This vacuum in military leadership resulted in the ascent of Rome as a military power. In fact, there is a period of overlap between the Hellenistic period and the Roman period, and some historians identify a fourth phase of Greek civilization—the so-called Roman phase—when the glory of the Greeks was on a decent and the military might of the Romans was on an ascent. Archimedes, Claudius Ptolemy, and Galen belonged to this period.

We have also seen that Greek philosophy started out by trying to make sense of the world that they saw, by trying to speculate why things are as they are. But in the hands of Plato and Aristotle it took a different shape. Their emphasis on pure thought instead of observation paved way for a mystic, idealistic way of thinking which inevitably leads to the development of imaginary and self-contained systems of belief. This is what happened in the early Roman period: many systems of belief sprouted. Then one would look at the external world on the basis of the belief system one sub-

scribes to. If some observation is consistent with the belief system, that would constitute the “truth”; and if some observation is inconsistent with it, that would be treated as insignificant, false, or unfit for intellectual attention. The Hellenistic period saw some instances of departure from this trend of thought, but this “Platonic” system ran as an undercurrent all through this period, and became dominant at the onset of the Roman era. The “neo-Platonism” gave rise to beliefs in supernatural powers, in fate, in various shades of mysticism, occult, and the practice of magical powers to reach the divine. In this cultural atmosphere, the cultivation of science died down.

The transition from slavery to feudalism

The Roman empire started with the same social structure as the Greeks: it was also a slave owning society. With the passage of time, slavery grew more and more brutal. At the same time the condition for a major change was slowly maturing. By that time the iron age was in an advanced stage, and the methods of agriculture and its implements, the method of the production of textile, and the production of iron and brass implements had advanced significantly. But the people engaged in production were slaves—who had no reason to be interested in an increase in production. Thus there prevailed a situation where the productive forces had advanced, but the

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Organizational News

master-slave production relation was holding back the advancement of production.

The catalyst for the change was provided by a slave revolt that started in 73 BC. Under the able leadership of the gladiator Spartacus, the slaves grouped themselves into an 1,00,000 strong army, and challenged the Roman legions. The battle continued for two years, and finally Spartacus' army was defeated in 71 BC. All the slaves taking part in the slave-army were murdered by the Roman generals Crassus and Pompey.

True, it was a failed revolt, but it changed the course of history. Following the revolt the common slave masters began to treat the slaves less harshly than before, out of sheer fear. With a large population of slaves killed, the number of available slaves reduced. The weakened army could not embark on fresh conquest of foreign land for some time, and so there was no fresh supply of slaves. In this situation the land-owners changed their strategy: Instead of getting the work done by the forced labour of slaves, they started engaging poor people and freed slaves as serfs. In this arrangement, a piece of land would be "allotted" to a serf, where he can produce a crop. The serf can keep a portion of the produce and has to give a lion's share to the land-owner. In this arrangement, even though the condition of the serfs continued to be wretched, they had reason to try to increase the production—because that would increase the fraction that he can keep for himself.

Thus started a phase of society which we call feudalism. It took a few centuries for this method of production to become widespread. By the time which we call the "middle age", the feudal form of production entrenched itself strongly in the whole of Europe.

By that time the glorious days of the Ro-

man empire were gone. The peak phase of the Roman empire lasted about three centuries: from the first century BC to the second century AD. Starting from the 4th century AD, the Roman empire failed to hold its ground in face of a series of invasions: The Goths invaded in 410 AD, Attila the Hun captured much of its territory in 451 AD, the Vandals pillaged Rome in 455 AD. Much of Europe, which was earlier under the Roman empire, went into a phase of uncertainty, chaos, and periodic waves of loot and plunder by warlords. The rich and powerful considered it unsafe to live in the cities and moved to their estates in the countryside. Slowly a stable form of feudal society developed.

What was the social condition then?

Firstly, the villages developed self-sufficient rural economy where most of the basic necessities of the people—food, clothing, pottery, furniture, metal implements, etc., were produced by serfs and local artisans in the village itself. The need for trade reduced, and became limited to the luxury goods for the aristocratic land-owners.

Secondly, the people became tied to the land as serfs for generations. Due to the lack of trade and commerce, the inter-regional cultural intercourse practically stopped. The conditions of feudal production put no fresh demand on scientific and technical inventions. Thus, a static form of society developed.

Every society creates a culture and a value system needed to maintain itself. The feudal society also created a value system which went to propagate and maintain the static nature of the society. The Platonic trend of philosophy had already created an ideal backdrop for it, by fathering many systems of belief. But in the late Greek or early Roman societies it was still in the form of individual beliefs, practised by groups of people. With the development of feudalism

Organizational News

a new feature was added: the development of *organized* religious faiths whose characteristic features were (a) hierarchic priesthood, (b) fixed rituals, (c) creeds involving the belief in an order of the universe, and (d) sacred books. In Europe the organized religious faith was provided by Christianity. But these characteristics were by no means the features of Christianity alone. The religions that developed in feudal times in other countries, like Buddhism in China and Japan, Hinduism in India, and Islam in the Arab world, all shared the same features.

The age of faith

Jesus Christ was born in Judea during the reign of Augustus Caesar (27 BC to 14 AD). As we have seen in the first instalment of this article, by then the idea of a God had already appeared in the society, and was prevalent in the Jewish community in which he was born. Jesus introduced the idea of a “Kingdom of Heaven” where all men were equal. All men were seen as children of a righteous God. However sinful, unjust and polluted the peoples’ lives may seem to be, there was justice waiting for them in the kingdom of God. It was a revolutionary idea. It struck at the heart of the oppressed, and in the initial phase played an important role in the struggle of the slaves.

But with the advent of feudalism, Christianity lost its revolutionary character and slowly assumed the role of defending the existing order of the society, and hence was welcomed by the ruling elite. It created a worldview of a static unchanging universe which was conducive to the static feudal economic order. In order to do that, it absorbed the ideas of Plato, Aristotle, and Ptolemy.

What was the worldview like? First, absorbing the ideas from tribal mythologies, it

created the idea that God created the world in a single stroke, in a span of just six days.¹ After the creation event, the world has been the same ever since. In this picture, everything has a “purpose” (see the link with “final cause” of Aristotle): the purpose of the cow is to provide milk to the humans; the purpose of grass is to provide food to the cow; so on and so forth. This is because God created everything with a purpose.

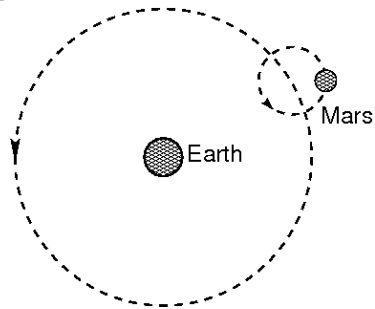
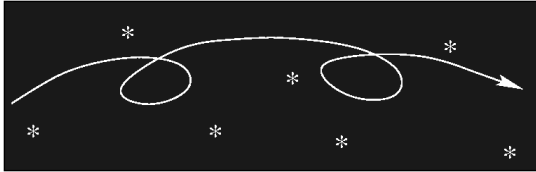
What is the universe like? By then it was known that the Earth was round. It was believed that this spherical Earth is at the centre of the universe, because it was the abode of man, whom the God created “in his own image”. Around the Earth, rotates the moon. But, we do see dark spots on the moon, that is, it is not “perfect”. Therefore it was believed that the moon is inside the Earth’s atmosphere. Everything outside the Earth’s atmosphere was believed to be perfect, divine, and unchanging.

What lies beyond the moon’s orbit? First, the sun, revolving around the Earth. The sun’s shape was believed to be a perfect circle, moving in circular orbit—because, following Pythagoras, it was believed that the circle is a “perfect” shape. Then come the planets. But there was a problem with the planets: Their motion was known to be quite complicated, at any rate their orbits cannot be circular. If one observes a planet like Mars for a few months, one would see the planet moving steadily against the starry background. Then its motion would slow down and stop. And then it would *turn backwards*. Again for some time it would continue in its backward motion, then stop, and then would resume its forward motion.

Two types of “explanation” of this motion went into the belief system. One said that

¹Notice that in Christian belief, God creates by the spoken command “Let there be . . .”, suggesting a comparison with a king—an aspect we have highlighted in the first instalment of this article.

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The apparent motion of the planet Mars, and Ptolemy's explanation based on epicycles.

there are concentric transparent crystal spheres on which the planets are embedded. God moves these crystal spheres, and the planets move as a result of that. There was another explanation due to Ptolemy, which was also included in the Christian cosmology. It said that the planets do not move in circles, but there are circles over circles, called "epicycles". As a result of this combined motion, the planets sometimes appear to move backwards. At that time five planets were known: Mercury, Venus, Mars, Jupiter, and Saturn. Their apparent motions had already been observed in great detail by Aristarchus and Hipparchus in the Hellenistic period. If one tried to tally the Ptolemaic picture with these observations, one would find that great many epicycles were needed in order to explain their apparent motions. But that was not considered to be any big problem, because so long as you do not probe deep, it offered a mental picture that could be believed.

What lies beyond the realm of planets? Here also Christian cosmology borrowed ideas from Aristotle. It was believed that there is a solid dark canopy that marks the end of the universe. The fixed stars are embedded on this dark sphere, which was, again, perfect, static, unchanging, and unchangeable.

Such beliefs became so deep-rooted, that when something at odds with the belief was

observed, people would disbelieve their own eyes and would ignore the event. For example, in the year 1054 a star exploded—a stellar event that we now call supernova—emitting very bright light that lasted a few days². The normally dim star became so bright that its intensity was comparable to that of the moon. And it was observable from the whole of the northern hemisphere. Yet, nobody in Europe reported having seen it. Nobody recorded it.

In the area of mechanics, Aristotle's ideas held sway. As we have seen in the last instalment, the central theme of Aristotle's mechanics was that force produces motion. Wherever there was motion, people assumed the application of force, and if the agent applying force was not clearly visible (as the horse pulling the cart), people assumed a divine role in making things move. Moreover, if force produces motion, a bigger force would produce a bigger motion. That is why it was believed that a heavier body would fall faster than a lighter body.

The biggest victim of this belief system was biology. Since it was believed that all living beings were created by God with some purpose, the study of biology boiled down to speculating about the *purpose* of each living thing. Moreover, since all species were

²We know about the event from the records of the Chinese astronomers, and by observing the remnant of that explosion—the Crab Nebula.

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believed to have been created by God in a single stroke, there was no question of any change or evolution. It took a long and arduous struggle for man to come out of this mindset.

After the phase of uncertainty and invasions, a stable form of governance emerged from the time of Charlemagne (742 AD to 814 AD). It was a system of dual rule of the king and the Church. The king governed the political and economic affairs and the Church governed the religious, cultural, and moral affairs, both helping each other. The king actively propagated Christianity, and the Church projected the king as the messenger of God, assigned the task of ruling. As the Church increased its hold over the minds of the population, it also increased its physical property. At the height of the middle age, the Church owned about one third the cultivable land of Europe.

In the medieval times, especially in the 12th century onwards, several universities were established in Oxford, Cambridge, Paris, and other places. But their purpose was mainly to train clergymen and officials for various roles in the Church and state hierarchy. The universities slowly became the centres for the study and propagation of the Christian belief system. The role of the professors was limited to studying the Bible and the writings of Aristotle at great lengths, and to provide interpretation of the world on that basis. This trend came to be known as 'scholasticism'.

Since the method of checking beliefs through observation and experimentation had not developed at that time, there was nothing to limit the subjective flights of fancy. Moreover the free practice of speculative philosophy of the Greek times gave way to one system of "official belief." Anything outside this system of belief amounted to questioning God in some way or other. Perpetuation of the belief

system required mechanisms of punishing the heretics. Thus a system of "inquisition" developed—a system of investigating and punishing those whose beliefs did not exactly fall in line with the official beliefs.

In such a cultural atmosphere, science died a silent death. For about a millennium and a half, no new discovery was made. Most of the developments of the Greek period fell into disuse, and were forgotten. It was a period of complete dominance of idealism and subjective thought, mixed with mysticism, obscurantism, and religious bigotry.

The veil over the dark age was to be lifted in the 15th and 16th centuries through a sweeping cultural transition that we call the renaissance. The social and economic conditions that created it, and the outcome of the great upheaval will be the subject matter of the next instalment of this essay. □

The earlier instalments of this article can be downloaded from our website www.breakthrough-india.org, link: Breakthrough magazine → Archive

With best wishes from

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