times called Corydallus, and this, we are told by Diodorus (iv. 59), was the scene of the contest.

Next in order to the plain of Eleusis came that of Athens, which is the most extensive of all, reaching from the foot of Parnes to the sea, and bounded on the west by Ægaleos, and on the east by Hymettus. Its most conspicuous feature is the broad line of dark green along its western side, formed by the olive-groves of Colonus and the gardens of the Academus, which owe their fertility to the waters of the Cephisus, by which they are irrigated. This river is fed by copious sources on the side of Mount Parnes, and thus, unlike the other rivers of Attica, has a constant supply of water; but it does not reach the sea, nor did it apparently in classical times, having been diverted, then as now, into the neighbouring plantations; for this is what Sophocles means when he speaks of "the sleepless fountains of Cephisus, which stray forth from their channels" (*Œd. Col.*, 685 *seq.*) The position of Colonus itself is marked by two bare knolls of light-coloured earth, which caused the poet in the same chorus to apply the epithet "white." (ἀργῆτα) to that place. On the opposite side of the plain runs the other river, the Ilissus, which rises from a beautiful fountain in Mount Hymettus, and skirts the eastern extremity of the city of Athens; but this, notwithstanding its celebrity, is a mere brook, which stands in pools a great part of the year, and in summer is completely dry. The situation of Athens relatively to the surrounding objects is singularly harmonious; for, while it forms a central point, so as to be the eye of the plain, and while the altar-rock of the Acropolis and the hills by which it is surrounded are conspicuous from every point of view, there is no such exactness in its position as to give formality, since it is nearer to the sea than to Parnes, and nearer to Hymettus than to Ægaleos. The most striking summit in the neighbourhood of the city is that of Lycabettus, now Mount St George, on the north-eastern side; and the variety is still further increased by the continuation of the ridge which it forms for some distance northwards through the plain. Three roads lead to Athens from the Bœotian frontier over the intervening mountain barrier—the easternmost over Parnes, from Delium and Oropus by Deceleia, which was the usual route of the invading Lacedæmonians during the Peloponnesian War; the westernmost over Cithæron, by the pass of Dryoscephalæ, or the "Oakheads," leading from Thebes by Platæa to Eleusis, and so to Athens, which we hear of in connection with the battle of Platæa, and with the escape of the Platæans at the time of the siege of that city in the Peloponnesian War; the third, midway between the two, by the pass of Phyle, near the summit of which, on a rugged height overlooking the Athenian plain, is the fort occupied by Thrasybulus in the days of the Thirty Tyrants. On the sea-coast to the south-west of Athens rises the hill of Munychia, a mass of rocky ground, forming the acropolis of the town of Piræeus, which was once separated from the mainland; for Strabo (i. 3, § 18) speaks of it as having been formerly an island. On one side of this, towards Hymettus, lay the open roadstead of Phalerum, on the other the harbour of Piræeus, a completely land-locked inlet, safe, deep, and spacious, the approach to which was still further narrowed by moles. The eastern side of the hill was further indented by two small but commodious havens, which were respectively called Zea and Munychia.

The north-eastern boundary of the plain of Athens is formed by the graceful pyramid of Pentelicus, which received its name from the deme of Pentele at its foot, but was far more commonly known as Brilessus in ancient times. This mountain did not form a continuous chain with Hymettus, for between them intervenes a level space of ground two miles in width, which formed the entrance to the Mesogæa, an elevated undulating plain in the midst of the mountains, reaching nearly to Sunium. At the extremity of Hymettus, where it projects into the Saronic Gulf, was the promontory of Zoster, or "the Girdle," which was so called because it girdles and protects the neighbouring harbour; but in consequence of the name, a legend was attached to it, to the effect that Latona had loosed her girdle there. From this promontory to Sunium there runs a lower line of mountains, and between these and the sea a fertile strip of land intervenes, which was called the Paralia. Beyond Sunium, on the eastern coast, were two safe ports, that of Thoricus, which is defended by the island of Helene, forming a natural breakwater in front of it, and that of Prasiæ, now called Porto Raphti, or "the Tailor," from a statue at the entrance to which the natives have given that name. But it still remains to mention the most famous spot of ground in Attica, the little plain of Marathon, which lay in the north-east corner, encircled on three sides by Parnes and Pentelicus, while the fourth faces the sea and the opposite coast of Eubœa. It was on the mountain slopes that the Greeks were stationed, while the Persians with their ships occupied the coast; and on the two sides the marshes may still be traced by which the movements of the invader's host were impeded. The mound, which at once attracts the eye in the centre of the level plain, is probably the burial-place of the Athenians who fell in the battle. The bay in front is sheltered by Eubœa, and is still more protected from the north by a projecting tongue of land, called Cynosura. The mountains in the neighbourhood were the seat of one of the political parties in Attica, the Diacrii or Hyperacrii, who, being poor mountaineers, and having nothing to lose, were the principal advocates of change; while, on the other hand, the Pedieis, or inhabitants of the plains, being wealthy landholders, formed the strong conservative element, and the Paroli, or occupants of the sea-coast, representing the mercantile interest, held an intermediate position between the two. Finally, there was one district of Attica, that lay without its natural boundaries, the territory of Oropus, which properly belonged to Bœotia, as it was situated to the north of Parnes; but on this the Athenians always endeavoured to retain a firm hold, because it facilitated their communications with Eubœa. The command of that island was of the utmost importance to them; for, if Ægina could rightly be called "the eyesore of the Piræeus," Eubœa was quite as truly a thorn in the side of Attica; for we learn from Demosthenes (*De Cor.*, p. 307) that at one period the pirates that made it their headquarters so infested the neighbouring sea as to prevent all navigation.

Present condition.

Of the condition of Attica in mediæval and modern times little need be said, for it has followed for the most part the fortunes of Athens. The population, however, has undergone a great change, independently of the large admixture of Slavonic blood that has affected the Greeks of the mainland generally, by the immigration of Albanian colonists, who now occupy a great part of the country. The most important of the classical ruins that remain outside Athens are those of the temple of Athena at Sunium, which form a conspicuous object as they surmount the headland, and gave rise to the name which it bore, until lately, of Cape Colonnæ; it is in the Doric style, of white marble, and 13 columns of the temple and a pilaster are now standing. At Eleusis the foundations of the *propylæa* of the great temple of Demeter and other buildings have been laid bare by excavation; at Thoricus there are remains of an ancient theatre; and at Rhamnus, northward from Marathon, at a little distance from the sea, are the basements and some of the columns of two temples in the same enclosure, which were dedicated to Nemesis and Themis.

(H. F. T.)

ATTICUS, Titus Pomponius, the friend of Cicero, was one of the most distinguished men during the period of the decline and fall of the Roman republic. His life gives an admirable picture of the classical man of culture, who, withdrawing from the stir of political affairs, devoted himself to literary and artistic pursuits. He was born at Rome 109 B.C., and was thus three years older than Cicero, along with whom he and the younger Marius were educated. His family is said to have been of noble and ancient descent; his father belonged to the equestrian order, and was very wealthy. When Pomponius (who afterwards received the surname Atticus, on account of his long residence at Athens, and his intimate acquaintance with Greek literature) was still a young man, his father died, and he at once took the prudent resolution of transferring himself and his fortune to Athens, in order to escape the dangers of the civil war, in which he might have been involved through his connection with the murdered tribune Sulpicius Rufus. Here, in retirement, he contrived to keep himself free from the entanglements of faction, while preserving friendly relations with all parties. Sulla, who urged him to come to Rome and join his party, took no offence at his refusal, but treated him with marked kindness. He assisted the younger Marius and Brutus with money when they were fleeing from their enemies, and remained on the most cordial terms with Cæsar and Pompey, Antony and Octavianus. His most intimate friend, however, was Cicero, whose correspondence with him extended over many years, and who seems to have found his prudent counsel and sympathy a remedy for all his many troubles. His private life was tranquil and happy. He did not marry till he was 53 years of age, and his only child became the wife of Vipsanius Agrippa, the distinguished minister of Augustus. His large fortune was increased on the death of his uncle, L. Cæcilius, who bequeathed to him the greater part of his property. He formed a large library at Athens, and kept a staff of slaves engaged in making copies of valuable works. He probably derived considerable profits from the sale of these books. In 32 B.C. he was seized with an illness believed to be incurable. He resolved not to protract a painful and hopeless struggle, and died after five days of voluntary starvation. As might have been expected from his easy temper and equable disposition, Atticus professed a mild Epicureanism, but philosophical problems, as such, do not seem to have had much interest for him; he was emphatically a man of literature. Of his writings none are extant, but we have notices of two, one a Greek history of Cicero's consulship, the other, in Latin, on Roman annals, a subject to which he had given much attention. This work was highly commended for its minute exactness, chronological accuracy, and simple style.

ATTICUS HERODES, Tiberius Claudius, a very wealthy citizen of Athens, was born about 104 A.D. His grandfather's estates had been confiscated for treachery, but the fortunes of the family had been restored by the discovery in his father's house of an enormous sum of money, which the Emperor Nerva permitted them to retain. This great wealth Herodes afterwards increased by his marriage. He received a careful education under the most distinguished masters of the time, and specially devoted himself to the study of oratory, to excel in which seems to have been the ruling motive of his life. While very young he delivered a speech before one of the emperors; but it was so ill received that he was with difficulty restrained from throwing himself into the Danube. He ultimately attained to great celebrity as a speaker and as a teacher of rhetoric. Among his pupils were Marcus Aurelius and Lucius Verus. He was highly esteemed by the Antonines, particularly by Aurelius, and received many marks of favour, among others the archonship at Athens and the consulate at Rome. Atticus is principally celebrated, however, for the vast sums he expended on public purposes. He built at Athens a great race-course of marble from Pentelicus, and a splendid musical theatre, called the Odeum. At Corinth he built a theatre, at Delphi a stadium, at Thermopylæ hot baths, at Canusium in Italy an aqueduct. He even contemplated cutting a canal through the Isthmus of Corinth, but it is said did not dare to carry out his plan because the same thing had been unsuccessfully attempted before by the Emperor Nero. Many of the partially ruined cities of Greece were restored by Atticus, and numerous inscriptions testify their gratitude to their benefactor. His wealth, and, it is reported, some disagreement with regard to one of the provisions of his father's will, roused up the enmity of the Athenians against him. He withdrew from Athens, and resided at his villa near Marathon, where he died about 180 A.D. None of his writings are extant.

ATTILA, or Etzel, the famous leader of the Huns, surnamed the "Fear of the World," or the "Scourge of God," was born probably about 406 A.D. His father Mundzuk, king of the Huns, was succeeded by his brothers Octar and Rhuas; and on the death of Rhuas, in 434, Attila and his brother Bleda together ascended the throne. They ruled not only over the Huns, but over nearly all the tribes north of the Danube and the Black Sea; under their banners fought Ostrogoths, Gepidæ, Alani, Heruli, and many other Teutonic peoples. Their dominions are said to have extended from the Rhine to the frontiers of China. Attila was superstitiously reverenced by his countrymen; he was said to possess the iron sword of the war-god, Mars, and he proclaimed himself to be the man-child born at Engaddi, who was destined to rule over the whole world. In 441 and 442 the brothers ravaged Thrace and Illyria, defeated the troops of the Eastern Empire in three great battles, and penetrated as far as Thermopylæ. Peace was made on the Romans agreeing to pay a heavy tribute. About this time Attila contrived to make away with his brother Bleda, and thus secured undivided supremacy. In 445 and the following years, he again directed his attacks against the Eastern Empire, and laid waste the whole country round Constantinople. Nowhere did he meet with resistance save from the brave little town of Azimus. The empire seemed about to succumb, when Theodosius entered into negotiations and made terms with his conqueror. While matters were being arranged, a plot was laid to assassinate Attila, in which the emperor was implicated. The conspiracy was discovered, and the barbarian upbraided the Christian monarch with his want of honour and manly courage. Theodosius died soon after, and his successor, Marcian, returned a firm refusal to Attila's demands for tribute. War seemed inevitable; but at this time the attention of the Hun was drawn to the Western Empire. It is said that the Princess Honoria, sister of Valentinian, tired of her life of enforced celibacy, sent her ring and an offer of her hand to Attila, who upon this grounded his claim to a part of the empire. It is probable, however, that he merely used this as a pretext, and that his real designs were more comprehensive. He evidently thought it a favourable opportunity for taking advantage of the enmity between the Romans and the Visigoths; and to this plan he was also induced by the proposals of Genseric, king of the Vandals, who offered to unite with him against his rival, Theodoric, king of the Visigoths. In 451 Attila assembled his forces, it is said 700,000 strong, led them through the centre of Germany, probably by Franconia, and crossed the Rhine, at what place cannot be determined. He defeated the Burgundians, and pushed on through the heart of Gaul, until his centre was checked by the valiant resistance offered

by Orleans. Meanwhile, Theodoric and Aëtius, the Roman general, had collected and united their forces, and marching with all speed, arrived in time to raise the siege of Orleans. Attila retreated to a position in the plain of Chalons, and there concentrated his forces for a great engagement. A tremendous battle ensued—one of the most gigantic as well as most important contests recorded in history. The Romans, who formed one wing, were driven back, and although they kept together, and at nightfall retired to the camp of the Visigoths, Aëtius had given up the day as lost. The Visigoths, who were on the other wing, had also been repulsed, and were discouraged by the fall of their leader Theodoric. But the fortune of the day was changed by the impetuous bravery of Thorismund, Theodoric's son, who, burning to avenge his father's fall, led on the infuriated Visigoths, and drove Attila back to his camp. He even penetrated into the fortifications, but was wounded and thrown from his horse, and his followers with difficulty carried him off. Next day, Attila remained in his camp in expectation of an attack, and having thrown all his baggage into a gigantic pile in the centre of the camp to be burned in case of defeat, resolved to sell his life dearly. But no attack was made; for Thorismund was persuaded by Aëtius to march to Toulouse in order to obtain his father's kingdom. Attila was thus enabled to retire in perfect security. Next year he poured his forces through the defiles of the Alps, and laid waste the whole north of Italy. Rome itself seemed likely to fall before the invader, when his course was arrested by an embassy headed by Pope Leo. Attila at once withdrew from Italy, but the motive which led him to act thus is not known. At the time his retreat was ascribed to a miraculous interposition of Providence, Peter and Paul having appeared in the camp of the Huns along with the embassy. The whole matter is rather obscure; and scarcely more credible is the story told by Jornandes that Attila invaded Gaul a second time and was completely defeated by Thorismund. No other historian mentions this circumstance. In the year 453, Attila died from the bursting of a blood-vessel on the night of his marriage with a beautiful Gothic maiden, called Ildiko, or Hilda. He was buried by his followers with great pomp and lamentation. The vast empire over which he had ruled broke up immediately after his death, no one chief being powerful enough to seize the supremacy. In person Attila is described as having been of true Hunnish type, short, but strongly made, with a large head, flat, wide-spread nostrils, and small glittering eyes. His presence was majestic and imposing, and he excelled all his followers in military exercises.

ATTOCK, a town and fort of British India, in the Panjáb, situated on the eastern bank of the Indus, in 33° 54′ N. lat., and 72° 20′ E. long. The place is both of political and commercial importance, as the Indus is here crossed by the military and trade route through the Khaibar Pass into Afghánistán. Alexander the Great, Tamerlane, and Nádir Sháh, are believed to have successively crossed the Indus at or about this spot in their respective invasions of India. The river runs past Attock in a deep rapid channel about 200 yards broad, but is easily crossed in boats or on inflated skins of oxen. A bridge of boats is maintained for a considerable part of the year, but withdrawn in the summer as soon as the melting of the snows in the northern mountains endangers it. The fort of Attock was built by the Emperor Akbar in 1581, on a low hillock beside the river. The walls are of polished stone, and the whole structure is handsome; but from a military point of view it is of little importance, being commanded by a hill, from which it is divided only by a ravine. The town was formerly a place of importance, but has now fallen into decay. On the opposite side of the river is the village of Khairábád, with a fort, also erected by Akbar according to some, or by Nádir Sháh according to others.

ATTORNEY, in *English Law*, signifies, in its widest sense, any substitute or agent appointed to act in "the turn, stead, or place of another." The term is now commonly confined to a class of qualified agents who undertake the conduct of legal proceedings for their clients. By the common law the actual presence of the parties to a suit was considered indispensable, but the privilege of appearing by attorney was conceded in certain cases by special dispensation, until the statute of Merton and subsequent enactments made it competent for both parties in all judicial proceedings to appear by attorney. Solicitors appear to have been at first distinguished from attorneys, as not having the attorney's power to bind their principals, but latterly the distinction has been between attorneys as the agents formally appointed in actions at-law, and solicitors who take care of proceedings in Parliament, Chancery, Privy Council, &c. In practice, however, and in ordinary language, the terms are synonymous. Regulations regarding the qualification of attorneys are found as far back as the 20 Edward I., which required the judges to select in each county the most learned and able attorneys and apprentices to do service in the courts. By the 6 and 7 Vict. c. 73, and other statutes, the qualifications necessary for admission on the rolls of attorneys and solicitors are:—1st, The due execution of a proper contract in writing with some practising attorney or solicitor for the term of five years, or of three years if the clerk be a graduate of the universities of Oxford, Cambridge, Dublin, London, or Durham, or of the Queen's University, Ireland, or if he have been a member of the bar, a writer to the signet, a solicitor before the supreme courts in Scotland, or for ten years *bona fide* managing clerk to an attorney; 2d, The payment of the stamp duty on such contract, amounting to £80; 3d, The registry or enrolment of the contract within six calendar months; 4th, Actual service for the prescribed period in the proper business of an attorney and solicitor; but one year may be served with the London agent, and, where the service is for five years, another year with a barrister or certificated special pleader; 5th, Due notices of the application to be admitted; 6th, Fitness and capacity ascertained upon examination, and certified by the examiners; 7th, Taking the prescribed oaths, and being admitted and enrolled; 8th, The certificate of the registrar of attorneys that he is duly enrolled, and the stamped certificate of the annual payment of the duty. Attorneys duly admitted in any of the superior courts have a right to be admitted and to practise in any of the courts in the kingdom, and this right may be enforced by mandamus. They may act as advocates in certain of the inferior courts. Conveyancing, formerly considered the exclusive business of the bar, is now often performed by attorneys. Barristers are understood to require the intervention of an attorney in all cases that come before them professionally, although in criminal cases the prisoner not unfrequently engages a counsel directly by giving him a fee in open court. The relation of attorney and client disqualifies the former from dealing with his client on his own behalf, while it gives him a lien, on professional services, over the deeds, &c., of the client in his possession. An attorney may be struck off the rolls for professional or other misconduct, on application by counsel at the instance of an injured party, or, as the case generally is, of the Incorporated Law Society as representing the profession.

A letter or power of Attorney is an authority under hand and seal, empowering the person named therein to do some act on behalf of the principal, which otherwise could only be done by the principal himself. It expires with death of the principal, and is revocable at his will, unless it has been given for a valuable consideration. *A warrant of Attorney* is an authority to one or more attorneys to appear for the party executing it, in a court of record, at the suit of the person for whose benefit it is given, and to suffer judgment summarily to pass in his favour. It is usually given as a security to creditors for the summary recovery of money lent, or sums certain, but may be used in other cases also.

ATTORNEY-GENERAL, the chief law officer appointed to manage all the legal affairs and suits in which the Crown is interested. He is appointed by patent, authorising him to hold office during the Queen's pleasure. He is *ex officio* the leader of the bar, and only counsel of the highest eminence are appointed to the office. The royal mandate of 14th December 1814 gives him precedence in all the courts, and it is now settled that in the House of Lords he has precedence of the Lord Advocate, even in Scotch appeals. He is a necessary party to all proceedings affecting the Crown, and has extensive powers of control in matters relating to charities, lunatics' estates, criminal prosecutions, &c. His assistant, also appointed by patent, is the Solicitor-General, who has full power to act in the absence of his principal, and by almost invariable usage, succeeds to his office when it becomes vacant. The income attached to these offices has hitherto been derived in great part from fees on patents for inventions, but by a recent arrangement the Attorney-General and Solicitor-General receive a salary of £7000 and £6000 respectively, exclusive of such fees as they may receive for any litigious business they may conduct on behalf of the Crown.

ATTRACTION. That the different parts of a material system influence each other's motions is a matter of daily observation. In some cases we cannot discover any material connection extending from the one body to the other. We call these cases of action at a distance, to distinguish them from those in which we can trace a continuous material bond of union between the bodies. The mutual action between two bodies is called stress. When the mutual action tends to bring the bodies nearer, or to prevent them from separating, it is called tension or attraction. When it tends to separate the bodies, or to prevent them from approaching, it is called pressure or repulsion. The names tension and pressure are used when the action is seen to take place through a medium. Attraction and repulsion are reserved for cases of action at a distance. The configuration of a material system can always be defined in terms of the mutual distances of the parts of the system. Any change of configuration must alter one or more of these distances. Hence the force which produces or resists such a change may be resolved into attractions or repulsions between those parts of the system whose distance is altered.

There has been a great deal of speculation as to the cause of such forces, one of them, namely, the pressure between bodies in contact, being supposed to be more easily conceived than any other kind of stress. Many attempts have therefore been made to resolve cases of apparent attraction and repulsion at a distance into cases of pressure. At one time the possibility of attraction at a distance was supposed to be refuted by asserting that a body cannot act where it is not, and that therefore all action between different portions of matter must be by direct contact. To this it was replied that we have no evidence that real contact ever takes place between two bodies, and that, in fact, when bodies are pressed against each other and in apparent contact, we may sometimes actually measure the distance between them, as when one piece of glass is laid on another, in which case a considerable pressure must be applied to bring the surfaces near enough to show the black spot of Newton's rings, which indicates a distance of about a ten thousandth of a millimetre. If, in order to get rid of the idea of action at a distance, we imagine a material medium through which the action is transmitted, all that we have done is to substitute for a single action at a great distance a series of actions at smaller distances between the parts of the medium, so that we cannot even thus get rid of action at a distance.

The study of the mutual action between the parts of a material system has, in modern times, been greatly simplified by the introduction of the idea of the energy of the system. The energy of the system is measured by the amount of work which it can do in overcoming external resistances. It depends on the present configuration and motion of the system, and not on the manner in which the system has acquired that configuration and motion. A complete knowledge of the manner in which the energy of the system depends on its configuration and motion, is sufficient to determine all the forces acting between the parts of the system. For instance, if the system consists of two bodies, and if the energy depends on the distance between them, then if the energy increases when the distance increases, there must be attraction between the bodies, and if the energy diminishes when the distance increases, there must be repulsion between them. In the case of two gravitating masses m and m' at a distance r, the part of the energy which depends on r is $-\frac{mm'}{r}$. We may therefore express the fact that there is attraction between the two bodies by saying that the energy of the system consisting of the two bodies increases when their distance increases. The question, therefore, Why do the two bodies attract each other? may be expressed in a different form. Why does the energy of the system increase when the distance increases?

But we must bear in mind that the scientific or science-producing value of the efforts made to answer these old standing questions is not to be measured by the prospect they afford us of ultimately obtaining a solution, but by their effect in stimulating men to a thorough investigation of nature. To propose a scientific question presupposes scientific knowledge, and the questions which exercise men's minds in the present state of science may very likely be such that a little more knowledge would show us that no answer is possible. The scientific value of the question, How do bodies act on one another at a distance? is to be found in the stimulus it has given to investigations into the properties of the intervening medium.

Newton, in his *Principia*, deduces from the observed motions of the heavenly bodies the fact that they attract one another according to a definite law. This he gives as a result of strict dynamical reasoning, and by it he shows how not only the more conspicuous phenomena, but all the apparent irregularities of the celestial motions are the calculable results of a single principle. In his *Principia* he confines himself to the demonstration and development of this great step in the science of the mutual action of bodies. He says nothing there about the means by which bodies gravitate towards each other. But his mind did not rest at this point. We know that he did not believe in the direct action of bodies at a distance.

> "It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact, as it must do if gravitation in the sense of Epicurus be essential and inherent in it. . . . That gravity should be innate, inherent, and essential to matter, so that one body can act upon another at a distance, through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it."—*Letter to Bentley.*

And we also know that he sought for the mechanism of

gravitation in the properties of an æthereal medium diffused over the universe.

"It appears, from his letters to Boyle, that this was his opinion early, and if he did not publish it sooner it proceeded from hence only, that he found he was not able, from experiment and observation, to give a satisfactory account of this medium and the manner of its operation in producing the chief phenomena of nature."[1]

In his *Optical Queries*, indeed, he shows that if the pressure of this medium is less in the neighbourhood of dense bodies than at great distances from them, dense bodies will be drawn towards each other, and that if the diminution of pressure is inversely as the distance from the dense body the law will be that of gravitation. The next step, as he points out, is to account for this inequality of pressure in the medium; and as he was not able to do this, he left the explanation of the cause of gravity as a problem to succeeding ages. As regards gravitation the progress made towards the solution of the problem since the time of Newton has been almost imperceptible. Faraday showed that the transmission of electric and magnetic forces is accompanied by phenomena occurring in every part of the intervening medium. He traced the lines of force through the medium; and he ascribed to them a tendency to shorten themselves and to separate from their neighbours, thus introducing the idea of stress in the medium in a different form from that suggested by Newton; for, whereas Newton's stress was a hydrostatic pressure in every direction, Faraday's is a tension along the lines of force, combined with a pressure in all normal directions. By showing that the plane of polarisation of a ray of light passing through a transparent medium in the direction of the magnetic force is made to rotate, Faraday not only demonstrated the action of magnetism on light, but by using light to reveal the state of magnetisation of the medium, he "illuminated," to use his own phrase, "the lines of magnetic force."

From this phenomenon Thomson afterwards proved, by strict dynamical reasoning, that the transmission of magnetic force is associated with a rotatory motion of the small parts of the medium. He showed, at the same time, how the centrifugal force due to this motion would account for magnetic attraction.

A theory of this kind is worked out in greater detail in Clerk Maxwell's *Treatise on Electricity and Magnetism*. It is there shown that, if we assume that the medium is in a state of stress, consisting of tension along the lines of force and pressure in all directions at right angles to the lines of force, the tension and the pressure being equal in numerical value and proportional to the square of the intensity of the field at the given point, the observed electrostatic and electromagnetic forces will be completely accounted for.

The next step is to account for this state of stress in the medium. In the case of electromagnetic force we avail ourselves of Thomson's deduction from Faraday's discovery stated above. We assume that the small parts of the medium are rotating about axes parallel to the lines of force. The centrifugal force due to this rotation produces the excess of pressure perpendicular to the lines of force. The explanation of electrostatic stress is less satisfactory, but there can be no doubt that a path is now open by which we may trace to the action of a medium all forces which, like the electric and magnetic forces, vary inversely as the square of the distance, and are attractive between bodies of different names and repulsive between bodies of the same names.

The force of gravitation is also inversely as the square of the distance, but it differs from the electric and magnetic forces in this respect, that the bodies between which it acts cannot be divided into two opposite kinds, one positive and the other negative, but are in respect of gravitation all of the same kind, and that the force between them is in every case attractive. To account for such a force by means of stress in an intervening medium, on the plan adopted for electric and magnetic forces, we must assume a stress of an opposite kind from that already mentioned. We must suppose that there is a pressure in the direction of the lines of force, combined with a tension in all directions at right angles to the lines of force. Such a state of stress would, no doubt, account for the observed effects of gravitation. We have not, however, been able hitherto to imagine any physical cause for such a state of stress. It is easy to calculate the amount of this stress which would be required to account for the actual effects of gravity at the surface of the earth. It would require a pressure of 37,000 tons' weight on the square inch in a vertical direction, combined with a tension of the same numerical value in all horizontal directions. The state of stress, therefore, which we must suppose to exist in the invisible medium, is 3000 times greater than that which the strongest steel could support.

Another theory of the mechanism of gravitation, that of Le Sage, who attributes it to the impact of "ultramundane corpuscules," has been already discussed in the article Atom, *supra*, p. 46.

Sir William Thomson[2] has shown that if we suppose all space filled with a uniform incompressible fluid, and if we further suppose either that material bodies are always generating and emitting this fluid at a constant rate, the fluid flowing off to infinity, or that material bodies are always absorbing and annihilating the fluid, the deficiency flowing in from infinite space, then, in either of these cases, there would be an attraction between any two bodies inversely as the square of the distance. If, however, one of the bodies were a generator of the fluid and the other an absorber of it, the bodies would repel each other.

Here, then, we have a hydrodynamical illustration of action at a distance, which is so far promising that it shows how bodies of the same kind may attract each other. But the conception of a fluid constantly flowing out of a body without any supply from without, or flowing into it without any way of escape, is so contradictory to all our experience, that an hypothesis, of which it is an essential part, cannot be called an *explanation* of the phenomenon of gravitation.

Dr Robert Hooke, a man of singular inventive power, in 1671 endeavoured to trace the cause of gravitation to waves propagated in a medium. He found that bodies floating on water agitated by waves were drawn towards the centre of agitation.[3] He does not appear, however, to have followed up this observation in such a way as to determine completely the action of waves on an immersed body.

Professor Challis has investigated the mathematical theory of the effect of waves of condensation and rarefaction in an elastic fluid on bodies immersed in the fluid. He found the difficulties of the investigation to be so great that he has not been able to arrive at numerical results. He concludes, however, that the effect of such waves would be to attract the body towards the centre of agitation, or to repel it from that centre, according as the wave's length is very large or very small compared with the dimensions of the body. Practical illustrations of the effect of such waves have been given by Guyot, Schellbach, Guthrie, and Thomson.[4]

A tuning-fork is set in vibration, and brought near a delicately suspended light body. The body is immediately attracted towards the tuning-fork. If the tuning-fork is itself suspended, it is seen to be attracted towards any body placed near it.

Sir W. Thomson has shown that this action can in all cases be explained by the general principle that in fluid motion the average pressure is least where the average energy of motion is greatest. Now, the wave motion is greatest nearest the tuning-fork, the pressure is therefore least there; and the suspended body being pressed unequally on opposite sides, moves from the side of greater pressure to the side of less pressure, that is towards the tuning-fork. He has also succeeded in producing repulsion in the case of a small body lighter than the surrounding medium.

It is remarkable that of the three hypotheses, which go some way towards a physical explanation of gravitation, every one involves a constant expenditure of work. Le Sage's hypothesis of ultramundane corpuscules does so, as we have shown in the article Atom. That of the generation or absorption of fluid requires, not only constant expenditure of work in emitting fluid under pressure, but actual creation and destruction of matter. That of waves requires some agent in a remote part of the universe capable of generating the waves.

According to such hypotheses we must regard the processes of nature not as illustrations of the great principle of the conservation of energy, but as instances in which, by a nice adjustment of powerful agencies not subject to this principle, an apparent conservation of energy is maintained. Hence, we are forced to conclude that the explanation of the cause of gravitation is not to be found in any of these hypotheses.

For the mathematical theory of attraction and attraction of ellipsoids, see Potential; for attraction of gravitation, capillary attraction, and attraction of cohesion, see respectively Gravitation, Capillary Attraction, and Constitution of Bodies. (J. C. M.)

ATTWOOD, Thomas, musical composer, was born in London in 1767. As one of the boy choristers in the chapel royal he received his early instruction in music from Nares and Ayrton. In 1783 he was sent to study abroad at the expense of the Prince of Wales, who had been favourably impressed by his skill as a performer on the harpsichord. After spending two years at Naples, Attwood proceeded to Vienna, where he became a favourite pupil of Mozart. On his return to London he held for a short time an appointment as one of the chamber musicians to the prince of Wales. In 1795 he was chosen organist of St Paul's, and in the following year he succeeded Dr Dupuis as composer to the chapels royal. His court connection was further confirmed by his appointment as musical instructor to the duchess of York and afterwards to the princess of Wales. For the coronation of George IV. he composed the anthem, *The King shall Rejoice*, a work of high merit. The king, who had neglected him for some years on account of his connection with the princess of Wales, now restored him to favour, and in 1821 appointed him organist to his private chapel at Brighton. Soon after the institution of the Royal Academy of Music, Attwood was chosen one of the professors. He wrote the anthem, *O Lord, grant the King a Long Life*, which was performed at the coronation of William IV., and he was composing a similar work for the coronation of Queen Victoria when he died (March 24, 1838). Attwood's compositions are favourable specimens of the English school. His services and anthems were published in a collected form after his death by his pupil Walmesley, and are frequently used in cathedral worship. Of his secular compositions several songs and glees are well known and popular. The operas which he composed in early life are now almost forgotten, belonging, as they do, to a period when English music was at its lowest ebb.

ATWOOD, George, an author celebrated for the accuracy of his mathematical and mechanical investigations, and considered particularly happy in the clearness of his explanations, and the elegance of his experimental illustrations, was born in the early part of the year 1746. He was educated at Westminster school, to which he was admitted in 1759. Six years afterwards he was elected *off* to Trinity College, Cambridge. He took his degree of Bachelor of Arts in 1769, with the rank of third wrangler and first Smith's prizeman. These distinctions were amply sufficient to give him a claim to further advancement in his own college. In due time he obtained a fellowship, and was afterwards one of the tutors of the college. He became Master of Arts in 1772, and in 1776 was elected a fellow of the Royal Society of London. In the year 1784 he ceased to reside at Cambridge, and soon afterwards received from Mr Pitt a patent office, which required but little of his attendance, and enabled him still to devote a considerable portion of his time to his special studies. He died in 1807. Atwood's published works, exclusive of papers contributed to the *Philosophical Transactions*, for one of which he obtained the Copley medal, are as follows:—(1.) *Analysis of a Course of Lectures on the Principles of Natural Philosophy*, Cambridge, 1784. (2.) *Treatise on the Rectilinear Motion and Rotation of Bodies*, Cambridge, 1784, which contains a good account of the elementary principles of mechanics, though it is deficient in the application of higher mathematical analysis. It also gives some interesting experiments, by means of which mechanical truths can be ocularly exhibited and demonstrated, and describes the machine, since called by Atwood's name, for verifying experimentally the laws of simple acceleration of motion. (3.) *Review of the Statutes and Ordinances of Assize which have been established in England from the 4th year of King John*, 1202, *to the 37th of his present Majesty*, London, 1801, a work of some historical research. (4.) *Dissertation on the Construction and Properties of Arches*, London, 1801, with supplement, pt. i. 1801, pt. ii. 1804, an elaborate and, in its time, valuable work, though it is now completely superseded.

ATYS, Attis, or Attes, in the *Phrygian and Lydian Mythology*, a youth beloved for his beauty by the goddess Rhea, there called Agdistis. Like Adonis, he was a personification of the changes in nature, from the beauty of spring and summer to the severity and darkness of winter. The story, as told at Pessinus, the centre of the worship of the goddess, was that she had born to Zeus a being both male and female; that the gods, displeased, had transformed this being into a tree, from the fruit of which the daughter of the river-god Sangarius bore a boy, who grew up among herdsmen marvellous in his beauty, so as to win the love of Agdistis. This was Atys, and he was about to be married to the king's daughter of Pessinus, when the goddess appeared among the guests, terrified them, and caused Atys to run to the woods, where he maimed himself and was transformed into a pine tree; from his blood sprang violets. Agdistis begged Zeus to restore him, but he could only assure her that the youth would never decay, and that his hair would always grow. She conveyed the pine to her cave at Pessinus, and gave herself up to grief.

AUBAGNE, a town of France, in the department of Bouches-du-Rhône, with a population of 7408, who carry on the manufacture of wine, pottery, leather, coarse cloth, &c. The only remarkable monument is a fountain to the memory of the Abbé Barthélemy, whose family was long connected with the town.

AUBE, a department of France, bounded on the N. by the department of Marne, N.W. by Seine-et-Marne, W.

[1] Maclaurin's account of Sir Isaac Newton's discoveries.

[2] *Proceedings of the Royal Society of Edinburgh*, 7th Feb. 1870.

[3] *Posthumous Works*, edited by R. Waller, pp. xiv and 184.

[4] *Philosophical Magazine*, June 1871.