THE PASCHAL CANON OF ANATOLIUS OF ALEXANDRIA

by Anatolius

A historical and chronological work by Anatolius of Alexandria, a renowned scholar and bishop, addressing the calculation of Easter and demonstrating the intersection of mathematics and Christian liturgy.

21 Chapters

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The Paschal Canon Of Anatolius Of Alexandria

Chapter 1

Introductory Notice to Anatolius and Minor Writers.

Instead of reprinting a disjointed mass of "Fragments," I have thought it desirable to present them in a group, illustrative of the Alexandrian school. I give to Anatolius the deserved place of prominence, marking him as the meet successor of Africanus in ability if not in the nature of his pursuits. His writing and the testimony of Eusebius prove him to have been a star of no inferior magnitude, even in the brilliant constellation of faith and genius of which he is part.These minor writers I have arranged, not with exclusive reference to minute chronology, but with some respect to their material, as follows: -- I. Anatolius, a.d.270.II. Alexander of Cappadocia, a.d.250.III. Theognostus, a.d.265.IV. Pierius, a.d.300.V. Theonas, a.d.300.VI. Phileas, a.d.307.VII. Pamphilus, a.d.309.

Chapter 2

Anatolius and Minor Writers.

Anatolius of Alexandria. Translator's Biographical Notice. [a.d.230-270-280.] From Jerome [1151] we learn that Anatolius flourished in the reign of Probus and Carus, that he was a native of Alexandria, and that he became bishop of Laodicea. Eusebius gives a somewhat lengthened account of him, [1152] and speaks of him in terms of the strongest laudation, as one surpassing all the men of his time in learning and science. He tells us that he attained the highest eminence in arithmetic, geometry, and astronomy, besides being a great proficient also in dialectics, physics, and rhetoric. His reputation was so great among the Alexandrians that they are said to have requested him to open a school for teaching the Aristotelian philosophy in their city. [1153] He did great service to his fellow-citizens in Alexandria on their being besieged by the Romans in a.d.262, and was the means of saving the lives of numbers of them. After this he is said to have passed into Syria, where Theotecnus, the bishop of Cæsareia, ordained him, destining him to be his own successor in the bishopric. After this, however, having occasion to travel to Antioch to attend the synod convened to deal with the case of Paul of Samosata, as he passed through the city of Laodicea, he was detained by the people and made bishop of the place, in succession to Eusebius. [1154] This must have been about the year 270 a.d. How long he held that dignity, however, we do not know. Eusebius tells us that he did not write many books, but yet enough to show us at once his eloquence and his erudition. Among these was a treatise on the Chronology of Easter; of which a considerable extract is preserved in Eusebius. The book itself exists now only in a Latin version, which is generally ascribed to Rufinus, and which was published by Ægidius Bucherius in his Doctrina Temporum, which was issued at Antwerp in 1634. Another work of his was the Institutes of Arithmetic, of which we have some fragments in the theologoumena tes arithmetikes, which was published in Paris in 1543. Some small fragments of his mathematical works, which have also come down to us, were published by Fabricius in his Bibliotheca Græca, iii. p.462.

Chapter 3

Section I. As we are about to speak on the subject of the order of the times

As we are about to speak on the subject of the order of the times and alternations of the world, we shall first dispose of the positions of diverse calculators; who, by reckoning only by the course of the moon, and leaving out of account the ascent and descent of the sun, with the addition of certain problems, have constructed diverse periods, [1156] self-contradictory, and such as are never found in the reckoning of a true computation; since it is certain that no mode of computation is to be approved, in which these two measures are not found together. For even in the ancient exemplars, that is, in the books of the Hebrews and Greeks, we find not only the course of the moon, but also that of the sun, and, indeed, not simply its course in the general, [1157] but even the separate and minutest moments of its hours all calculated, as we shall show at the proper time, when the matter in hand demands it. Of these Hippolytus made up a period of sixteen years with certain unknown courses of the moon. Others have reckoned by a period of twenty-five years, others by thirty, and some by eighty-four years, without, however, teaching thereby an exact method of calculating Easter. But our predecessors, men most learned in the books of the Hebrews and Greeks, -- I mean Isidore and Jerome and Clement, -- although they have noted similar beginnings for the months just as they differ also in language, have, nevertheless, come harmoniously to one and the same most exact reckoning of Easter, day and month and season meeting in accord with the highest honour for the Lord's resurrection. [1158] But Origen also, the most erudite of all, and the acutest in making calculations, -- a man, too, to whom the epithet chalkeutes [1159] is given, -- has published in a very elegant manner a little book on Easter. And in this book, while declaring, with respect to the day of Easter, that attention must be given not only to the course of the moon and the transit of the equinox, but also to the passage (transcensum) of the sun, which removes every foul ambush and offence of all darkness, and brings on the advent of light and the power and inspiration of the elements of the whole world, he speaks thus: In the (matter of the) day of Easter, he remarks, I do not say that it is to be observed that the Lord's day should be found, and the seven [1160] days of the moon which are to elapse, but that the sun should pass that division, to wit, between light and darkness, constituted in an equality by the dispensation of the Lord at the beginning of the world; and that, from one hour to two hours, from two to three, from three to four, from four to five, from five to six hours, while the light is increasing in the ascent of the sun, the darkness should decrease. [1161] ...and the addition of the twentieth number being completed, twelve parts should be supplied in one and the same day. But if I should have attempted to add any little drop of mine [1162] after the exuberant streams of the eloquence and science of some, what else should there be to believe but that it should be ascribed by all to ostentation, and, to speak more truly, to madness, did not the assistance of your promised prayers animate us for a little? For we believe that nothing is impossible to your power of prayer, and to your faith. Strengthened, therefore, by this confidence, we shall set bashfulness aside, and shall enter this most deep and unforeseen sea of the obscurest calculation, in which swelling questions and problems surge around us on all sides.

Section II. There is, then, in the first year, the new moon of the first month

There is, then, in the first year, the new moon of the first month, which is the beginning of every cycle of nineteen years, on the six and twentieth day of the month called by the Egyptians Phamenoth. [1163] But, according to the months of the Macedonians, it is on the two-and-twentieth day of Dystrus. And, as the Romans would say, it is on the eleventh day before the Kalends of April. Now the sun is found on the said six-and-twentieth day of Phamenoth, not only as having mounted to the first segment, but as already passing the fourth day in it. And this segment they are accustomed to call the first dodecatemorion (twelfth part), and the equinox, and the beginning of months, and the head of the cycle, and the starting-point [1164] of the course of the planets. And the segment before this they call the last of the months, and the twelfth segment, and the last dodecatemorion, and the end of the circuit [1165] of the planets. And for this reason, also, we maintain that those who place the first month in it, and who determine the fourteenth day of the Paschal season by it, make no trivial or common blunder.

Section III. Nor is this an opinion confined to ourselves alone.

Nor is this an opinion confined to ourselves alone. For it was also known to the Jews of old and before Christ, and it was most carefully observed by them. [1166] And this may be learned from what Philo, and Josephus, and Musæus have written; and not only from these, but indeed from others still more ancient, namely, the two Agathobuli, [1167] who were surnamed the Masters, and the eminent Aristobulus, [1168] who was one of the Seventy who translated the sacred and holy Scriptures of the Hebrews for Ptolemy Philadelphus and his father, and dedicated his exegetical books on the law of Moses to the same kings. These writers, in solving some questions which are raised with respect to Exodus, say that all alike ought to sacrifice the Passover [1169] after the vernal equinox in the middle of the first month. And that is found to be when the sun passes through the first segment of the solar, or, as some among them have named it, the zodiacal circle.

Chapter 6

Section IV. But this Aristobulus also adds, that for the feast of the Passover it was necessary

But this Aristobulus also adds, that for the feast of the Passover it was necessary not only that the sun should pass the equinoctial segment, but the moon also. For as there are two equinoctial segments, the vernal and the autumnal, and these diametrically opposite to each other, and since the day of the Passover is fixed for the fourteenth day of the month, in the evening, the moon will have the position diametrically opposite the sun; as is to be seen in full moons. And the sun will thus be in the segment of the vernal equinox, and the moon necessarily will be at the autumnal equinox.

Section V. I am aware that very many other matters were discussed by them

I am aware that very many other matters were discussed by them, some of them with considerable probability, and others of them as matters of the clearest demonstration, [1170] by which they endeavour to prove that the festival of the Passover and unleavened bread ought by all means to be kept after the equinox. But I shall pass on without demanding such copious demonstrations (on subjects [1171]) from which the veil of the Mosaic law has been removed; for now it remains for us with unveiled face to behold ever as in a glass Christ Himself and the doctrines and sufferings of Christ. But that the first month among the Hebrews is about the equinox, is clearly shown also by what is taught in the book of Enoch. [1172]

Section VI. And, therefore, in this concurrence of the sun and moon

And, therefore, in this concurrence of the sun and moon, the Paschal festival is not to be celebrated, because as long as they are found in this course the power of darkness is not overcome; and as long as equality between light and darkness endures, and is not diminished by the light, it is shown that the Paschal festival is not to be celebrated. Accordingly, it is enjoined that that festival be kept after the equinox, because the moon of the fourteenth, [1173] if before the equinox or at the equinox, does not fill the whole night. But after the equinox, the moon of the fourteenth, with one day being added because of the passing of the equinox, although it does not extend to the true light, that is, the rising of the sun and the beginning of day, will nevertheless leave no darkness behind it. And, in accordance with this, Moses is charged by the Lord to keep seven days of unleavened bread for the celebration of the Passover, that in them no power of darkness should be found to surpass the light. And although the outset of four nights begins to be dark, that is, the 17th and 18th and 19th and 20th, yet the moon of the 20th, which rises before that, does not permit the darkness to extend on even to midnight.

Chapter 9

Section VII. To us, however, with whom it is impossible for all these things to come aptly

To us, however, with whom it is impossible for all these things to come aptly at one and the same time, namely, the moon's fourteenth, and the Lord's day, and the passing of the equinox, and whom the obligation of the Lord's resurrection binds to keep the Paschal festival on the Lord's day, it is granted that we may extend the beginning of our celebration even to the moon's twentieth. For although the moon of the 20th does not fill the whole night, yet, rising as it does in the second watch, it illumines the greater part of the night. Certainly if the rising of the moon should be delayed on to the end of two watches, that is to say, to midnight, the light would not then exceed the darkness, but the darkness the light. But it is clear that in the Paschal feast it is not possible that any part of the darkness should surpass the light; for the festival of the Lord's resurrection is one of light, and there is no fellowship between light and darkness. And if the moon should rise in the third watch, it is clear that the 22d or 23d of the moon would then be reached, in which it is not possible that there can be a true celebration of Easter. For those who determine that the festival may be kept at this age of the moon, are not only unable to make that good by the authority of Scripture, but turn also into the crime of sacrilege and contumacy, and incur the peril of their souls; inasmuch as they affirm that the true light may be celebrated along with something of that power of darkness which dominates all.

Chapter 10

Section VIII. Accordingly, it is not the case, as certain calculators of Gaul allege

Accordingly, it is not the case, as certain calculators of Gaul allege, that this assertion is opposed by that passage in Exodus, [1174] where we read: "In the first month, on the fourteenth day of the first month, at even, ye shall eat unleavened bread until the one-and-twentieth day of the month at even. Seven days shall there be no leaven found in your houses." From this they maintain that it is quite permissible to celebrate the Passover on the twenty-first day of the moon; understanding that if the twenty-second day were added, there would be found eight days of unleavened bread. A thing which cannot be found with any probability, indeed, in the Old Testament, as the Lord, through Moses, gives this charge: "Seven days ye shall eat unleavened bread." [1175] Unless perchance the fourteenth day is not reckoned by them among the days of unleavened bread with the celebration of the feast; which, however, is contrary to the Word of the Gospel which says: "Moreover, on the first day of unleavened bread, the disciples came to Jesus." [1176] And there is no doubt as to its being the fourteenth day on which the disciples asked the Lord, in accordance with the custom established for them of old, "Where wilt Thou that we prepare for Thee to eat the Passover?" But they who are deceived with this error maintain this addition, because they do not know that the 13th and 14th, the 14th and 15th, the 15th and 16th, the 16th and 17th, the 17th and 18th, the 18th and 19th, the 19th and 20th, the 20th and 21st days of the moon are each found, as may be most surely proved, within a single day. For every day in the reckoning of the moon does not end in the evening as the same day in respect of number, as it is at its beginning in the morning. For the day which in the morning, that is up to the sixth hour and half, is numbered the 13th day of the month, is found at even to be the 14th. Wherefore, also, the Passover is enjoined to be extended on to the 21st day at even; which day, without doubt, in the morning, that is, up to that term of hours which we have mentioned, was reckoned the 20th. Calculate, then, from the end of the 13th [1177] day of the moon, which marks the beginning of the 14th, on to the end of the 20th, at which the 21st day also begins, and you will have only seven days of unleavened bread, in which, by the guidance of the Lord, it has been determined before that the most true feast of the Passover ought to be celebrated.

Section IX. But what wonder is it that they should have erred in the matter of the

But what wonder is it that they should have erred in the matter of the 21st day of the moon who have added three days before the equinox, in which they hold that the Passover may be celebrated? An assertion which certainly must be considered altogether absurd, since, by the best-known historiographers of the Jews, and by the Seventy Elders, it has been clearly determined that the Paschal festival cannot be celebrated at the equinox.

Section X. But nothing was difficult to them with whom it was lawful to celebrate the Passover

But nothing was difficult to them with whom it was lawful to celebrate the Passover on any day when the fourteenth of the moon happened after the equinox. Following their example up to the present time all the bishops of Asia -- as themselves also receiving the rule from an unimpeachable authority, to wit, the evangelist John, who leant on the Lord's breast, and drank in instructions spiritual without doubt -- were in the way of celebrating the Paschal feast, without question, every year, whenever the fourteenth day of the moon had come, and the lamb was sacrificed by the Jews after the equinox was past; not acquiescing, so far as regards this matter, with the authority of some, namely, the successors of Peter and Paul, who have taught all the churches in which they sowed the spiritual seeds of the Gospel, that the solemn festival of the resurrection of the Lord can be celebrated only on the Lord's day. Whence, also, a certain contention broke out between the successors of these, namely, Victor, at that time bishop of the city of Rome, and Polycrates, who then appeared to hold the primacy among the bishops of Asia. And this contention was adjusted most rightfully by Irenæus, [1178] at that time president of a part of Gaul, so that both parties kept by their own order, and did not decline from the original custom of antiquity. The one party, indeed, kept the Paschal day on the fourteenth day of the first month, according to the Gospel, as they thought, adding nothing of an extraneous kind, but keeping through all things the rule of faith. And the other party, passing the day of the Lord's Passion as one replete with sadness and grief, hold that it should not be lawful to celebrate the Lord's mystery of the Passover at any other time but on the Lord's day, on which the resurrection of the Lord from death took place, and on which rose also for us the cause of everlasting joy. For it is one thing to act in accordance with the precept given by the apostle, yea, by the Lord Himself, and be sad with the sad, and suffer with him that suffers by the cross, His own word being: "My soul is exceeding sorrowful, even unto death;" [1179] and it is another thing to rejoice with the victor as he triumphs over an ancient enemy, and exults with the highest triumph over a conquered adversary, as He Himself also says: "Rejoice with Me; for I have found the sheep which I had lost." [1180]

Section XI. Moreover, the allegation which they sometimes make against us

Moreover, the allegation which they sometimes make against us, that if we pass the moon's fourteenth we cannot celebrate the beginning of the Paschal feast in light, [1181] neither moves nor disturbs us. For, although they lay it down as a thing unlawful, that the beginning of the Paschal festival should be extended so far as to the moon's twentieth; yet they cannot deny that it ought to be extended to the sixteenth and seventeenth, which coincide with the day on which the Lord rose from the dead. But we decide that it is better that it should be extended even on to the twentieth day, on account of the Lord's day, than that we should anticipate the Lord's day on account of the fourteenth day; for on the Lord's day was it that light was shown to us in the beginning, and now also in the end, the comforts of all present and the tokens of all future blessings. For the Lord ascribes no less praise to the twentieth day than to the fourteenth. For in the book of Leviticus [1182] the injunction is expressed thus: "In the first month, on the fourteenth day of this month, at even, is the Lord's Passover. And on the fifteenth day of this month is the feast of unleavened bread unto the Lord. Seven days ye shall eat unleavened bread. The first day shall be to you one most diligently attended [1183] and holy. Ye shall do no servile work thereon. And the seventh day shall be to you more diligently attended [1184] and holier; ye shall do no servile work thereon." And hence we maintain that those have contracted no guilt [1185] before the tribunal of Christ, who have held that the beginning of the Paschal festival ought to be extended to this day. And this, too, the most especially, as we are pressed by three difficulties, namely, that we should keep the solemn festival of the Passover on the Lord's day, and after the equinox, and yet not beyond the limit of the moon's twentieth day.

Section XII. But this again is held by other wise and most acute men to be an

But this again is held by other wise and most acute men to be an impossibility, because within that narrow and most contracted limit of a cycle of nineteen years, a thoroughly genuine Paschal time, that is to say, one held on the Lord's day and yet after the equinox, cannot occur. But, in order that we may set in a clearer light the difficulty which causes their incredulity, we shall set down, along with the courses of the moon, that cycle of years which we have mentioned; the days being computed before in which the year rolls on in its alternating courses, by Kalends and Ides and Nones, and by the sun's ascent and descent.

Section XIII. The moon's age set forth in the Julian Calendar.

The moon's age set forth in the Julian Calendar. January, on the Kalends, one day, the moon's first (day); on the Nones, the 5th day, the moon's 5th; on the Ides, the 13th day, the moon's 13th. On the day before the Kalends of February, the 31st day, the moon's 1st; on the Kalends of February, the 32d day, the moon's 2d; on the Nones, the 36th day, the moon's 6th; on the Ides, the 44th day, the moon's 14th. On the day before the Kalends of March, the 59th day, the moon's 29th; on the Kalends of March, the 60th day, the moon's 1st; on the Nones, the 66th day, the moon's 7th; on the Ides, the 74th day, the moon's 15th. On the day before the Kalends of April, the 90th day, the moon's 2d; on the Kalends of April, the 91st day, the moon's 3d; on the Nones, the 95th day, the moon's 7th; on the Ides, the 103d day, the moon's 15th. On the day before the Kalends of May, the 120th day, the moon's 3d; on the Kalends of May, the 121st day, the moon's 4th; on the Nones, the 127th day, the moon's 10th; on the Ides, the 135th day, the moon's 18th. On the day before the Kalends of June, the 151st day, the moon's 3d; on the Kalends of June, the 152d day, the moon's 5th; on the Nones, the 153d day, the moon's 9th; on the Ides, the 164th day, the moon's 17th. On the day before the Kalends of July, the 181st day, the moon's 5th; on the Kalends of July, the 182d day, the moon's 6th; on the Nones, the 188th day, the moon's 12th; on the Ides, the 196th day, the moon's 20th. On the day before the Kalends of August, the 212th day, the moon's 5th; on the Kalends of August, the 213th day, the moon's 7th; on the Nones, the 217th day, the moon's 12th; on the Ides, the 225th day, the moon's 19th. On the day before the Kalends of September, the 243d day, the moon's 7th; on the Kalends of September, the 244th day, the moon's 8th; on the Nones, the 248th day, the moon's 12th; on the Ides, the 256th day, the moon's 20th. On the day before the Kalends of October, the 273d day, the moon's 8th; on the Kalends of October, the 247th day, the moon's 9th; on the Nones, the 280th day, the moon's 15th; on the Ides, the 288th day, the moon's 23d. On the day before the Kalends of November, the 304th day, the moon's 9th; on the Kalends of November, the 305th day, the moon's 10th; on the Nones, the 309th day, the moon's 14th; on the Ides, the 317th day, the moon's 22d. On the day before the Kalends of December, the 334th day, the moon's 10th; on the Kalends of December, the 335th day, the moon's 11th; on the Nones, the 339th day, the moon's 15th; on the Ides, the 347th day, the moon's 23d. On the day before the Kalends of January, the 365th day, the moon's 11th; on the Kalends of January, the 366th day, the moon's 12th.

Section XIV. The Paschal or Easter Table of Anatolius.

The Paschal or Easter Table of Anatolius. Now, then, after the reckoning of the days and the exposition of the course of the moon, whereon the whole revolves on to its end, the cycle of the years may be set forth from the commencement. [1186] This makes the Passover (Easter season) circulate between the 6th day before the Kalends of April and the 9th before the Kalends of May, according to the following table: Equinox / Moon / Easter / Moon 1. Sabbath / XXVI. / XVth before the Kalends of May, i.e., 17th April / XVIII. 2. Lord's Day / VII. / Kalends of April, i.e., 1st April / XIV. 3. IId Day (ferial) / XVIII. / XIth before the Kalends of May, i.e., 21st April / XVI. 4. IIId Day / XXIX. / Ides of April, i.e., 13th April / XIX. 5. IVth Day / X. / IVth before the Kalends of April, i.e., 29th March / XIV. 6. Vth Day / XXI. / XIVth before the Kalends of May, i.e., 18th April / XVI. 7. Sabbath [1187] / II. / VIth before the Kalends of April, i.e., 27th March / XVII. 8. Lord's Day / XIII. / Kalends of April, i.e., 1st of April / XX. 9. IId Day / XXIV. / XVIIIth before the Kalends of May, i.e., 14th March / XV.10. IIId Day / V. / VIIIth before the Ides of April, i.e., 6th April / XV.11. IVth Day / XVI. / IVth before the Kalends of April, i.e., 29th March / XX.12. Vth Day / XXVII. / IIId before the Ides of April, i.e., 11th April / XV.13. VIth Day / VIII. / IIId before the Nones of April, i.e., 3rd April / XVII.14. Sabbath / XX. / IXth before the Kalends of May, i.e., 23rd April / XX.15. Lord's Day / I. / VIth before the Ides of April, i.e., 8th April / XV.16. IId Day / XII. / IId before the Kalends of April, i.e., 31st March / XVIII.17. IVth Day [1188] / XXIII. / XIVth before the Kalends of May, i.e., 18th April / XIX.18. Vth Day / IV. / IId before the Nones of April, i.e., 4th April / XIV.19. VIth Day / XV. / VIth before the Kalends of April, i.e., 27th March / XVII.

Section XV. This cycle of nineteen years is not approved of by certain African investigators who have

This cycle of nineteen years is not approved of by certain African investigators who have drawn up larger cycles, because it seems to be somewhat opposed to their surmises and opinions. For these make up the best proved accounts according to their calculation, and determine a certain beginning or certain end for the Easter season, so as that the Paschal festival shall not be celebrated before the eleventh day before the Kalends of April, i.e., 24th March, nor after the moon's twenty-first, and the eleventh day before the Kalends of May, i.e., 21st April. But we hold that these are limits not only not to be followed, but to be detested and overturned. For even in the ancient law it is laid down that this is to be seen to, viz., that the Passover be not celebrated before the transit of the vernal equinox, at which the last of the autumnal term is overtaken, [1189] on the fourteenth day of the first month, which is one calculated not by the beginnings of the day, but by those of the moon. [1190] And as this has been sanctioned by the charge of the Lord, and is in all things accordant with the Catholic faith, it cannot be doubtful to any wise man that to anticipate it must be a thing unlawful and perilous. And, accordingly, this only is it sufficient for all the saints and Catholics to observe, namely, that giving no heed to the diverse opinions of very many, they should keep the solemn festival of the Lord's resurrection within the limits which we have set forth.

Section XVI. Furthermore, as to the proposal subjoined to your epistle

Furthermore, as to the proposal subjoined to your epistle, that I should attempt to introduce into this little book some notice of the ascent and descent of the sun, which is made out in the distribution of days and nights. The matter proceeds thus: In fifteen days and half an hour, the sun ascending by so many minutes, that is, by four in one day, from the eighth day before the Kalends of January, i.e., 25th December, to the eighth before the Kalends of April, i.e., 25th March, an hour is taken up; [1191] at which date there are twelve hours and a twelfth. On this day, towards evening, if it happen also to be the moon's fourteenth, the lamb was sacrificed among the Jews. But if the number went beyond that, so that it was the moon's fifteenth or sixteenth on the evening of the same day, on the fourteenth day of the second moon, in the same month, the Passover was celebrated; and the people ate unleavened bread for seven days, up to the twenty-first day at evening. Hence, if it happens in like manner to us, that the seventh day before the Kalends of April, 26th March, proves to be both the Lord's day and the moon's fourteenth, Easter is to be celebrated on the fourteenth. But if it proves to be the moon's fifteenth or sixteenth, or any day up to the twentieth, then our regard for the Lord's resurrection, which took place on the Lord's day, will lead us to celebrate it on the same principle; yet this should be done so as that the beginning of Easter may not pass beyond the close of their festival, that is to say, the moon's twentieth. And therefore we have said that those parties have committed no trivial offence who have ventured either on anticipating or on going beyond this number, which is given us in the divine Scriptures themselves. And from the eighth day before the Kalends of April, 25th March, to the eighth before the Kalends of July, 24th June, in fifteen days an hour is taken up: the sun ascending every day by two minutes and a half, and the sixth part of a minute. And from the eighth day before the Kalends of July, 24th June, to the eighth before the Kalends of October, 24th September, in like manner, in fifteen days and four hours, an hour is taken up: the sun descending every day by the same number of minutes. And the space remaining on to the eighth day before the Kalends of January, 25th December, is determined in a similar number of hours and minutes. So that thus on the eighth day before the Kalends of January, for the hour there is the hour and half. For up to that day and night are distributed. And the twelve hours which were established at the vernal equinox in the beginning by the Lord's dispensation, being distributed over the night on the eighth before the Kalends of July, the sun ascending through those eighteen several degrees which we have noted, shall be found conjoined with the longer space in the twelfth. And, again, the twelve hours which should be fulfilled at the autumnal equinox in the sun's descent, should be found disjoined on the sixth before the Kalends of January as six hours divided into twelve, the night holding eighteen divided into twelve. And on the eighth before the Kalends of July, in like manner, it held six divided into twelve.

Section XVII. Be not ignorant of this, however, that those four determining periods

Be not ignorant of this, however, that those four determining periods, [1192] which we have mentioned, although they are approximated to the Kalends of the following months, yet hold each the middle of a season, viz., of spring and summer, and autumn and winter. And the beginnings of the seasons are not to be fixed at that point at which the Kalends of the month begin. But each season is to be begun in such way that the equinox divides the season of spring from its first day; and the season of summer is divided by the eighth day before the Kalends of July, and that of autumn by the eighth before the Kalends of October, and that of winter by the eighth before the Kalends of January in like manner. [1193]

Chapter 20

Fragments of the Books on Arithmetic.

What is mathematics? Aristotle thinks that all philosophy consisted of theory and practice, [1195] and divides the practical into ethical and political, and the theoretic again into the theological, the physical, and the mathematical. And thus very clearly and skilfully he shows that mathematics is (a branch of) philosophy. The Chaldæans were the originators of astronomy, and the Egyptians of geometry and arithmetic.... And whence did mathematics derive its name? Those of the Peripatetic school affirmed that in rhetoric and poetry, and in the popular music, any one may be an adept though he has gone through no process of study; but that in those pursuits properly called studies, [1196] none can have any real knowledge unless he has first become a student of them. Hence they supposed that the theory of these things was called Mathematics, from mathema, study, science. And the followers of Pythagoras are said to have given this more distinctive name of mathematics to geometry, and arithmetic alone. For of old these had each its own separate name; and they had up till then no name common to both. And he (Archytas) gave them this name, because he found science [1197] in them, and that in a manner suitable to man's study. [1198] For they (the Pythagoreans) perceived that these studies dealt with things eternal and immutable and perfect, [1199] in which things alone they considered that science consisted. But the more recent philosophers have given a more extensive application to this name, so that, in their opinion, the mathematician deals not only with substances [1200] incorporeal, and falling simply within the province of the understanding, [1201] but also with that which touches upon corporeal and sensible matter. For he ought to be cognisant of [1202] the course of the stars, and their velocity, and their magnitudes, and forms, and distances. And, besides, he ought to investigate their dispositions to vision, examining into the causes, why they are not seen as of the same form and of the same size from every distance, retaining, indeed, as we know them to do, their dispositions relative to each other, [1203] but producing, at the same time, deceptive appearances, both in respect of order and position. And these are so, either as determined by the state of the heavens and the air, or as seen in reflecting and all polished surfaces and in transparent bodies, and in all similar kinds. In addition to this, they thought that the man ought to be versed in mechanics and geometry and dialectics. And still further, that he should engage himself with the causes of the harmonious combination of sounds, and with the composition of music; which things are bodies, [1204] or at least are to be ultimately referred to sensible matter. What is mathematics? Mathematics is a theoretic science [1205] of things apprehensible by perception and sensation for communication to others. [1206] And before this a certain person indulging in a joke, while hitting his mark, said that mathematics is that science to which Homer's description of Discord may be applied. -- "Small at her birth, but rising every hour, While scarce the skies her horrid (mighty) head can bound, She stalks on earth and shakes the world around." [1207] For it begins with a point and a line, [1208] and forthwith it takes heaven itself and all things within its compass.How many divisions are there of mathematics?Of the more notable and the earliest mathematics there are two principal divisions, viz., arithmetic and geometry. And of the mathematics which deals with things sensible there are six divisions, viz., computation (practical arithmetic), geodesy, optics, theoretical music, mechanics, and astronomy. But that neither the

so-called tactics nor architecture, [1209] nor the popular music, nor physics, nor the art which is called equivocally the mechanical, constitutes, as some think, a branch of mathematics, we shall prove, as the discourse proceeds, clearly and systematically.As to the circle having eight solids and six superficies and four angles....What branches of arithmetic have closest affinity with each other? Computation and theoretical music have a closer affinity than others with arithmetic; for this department, being one also of quantity and ratio, approaches it in number and proportion. [1210] Optics and geodesy, again, are more in affinity with geometry. And mechanics and astrology are in general affinity with both.As to mathematics having its principles [1211] in hypothesis and about hypothesis. Now, the term hypothesis is used in three ways, or indeed in many ways. For according to one usage of the term we have the dramatic revolution; [1212] and in this sense there are said to be hypotheses in the dramas of Euripides. According to a second meaning, we have the investigation of matters in the special in rhetoric; and in this sense the Sophists say that a hypothesis must be proposed. And, according to a third signification, the beginning of a proof is called a hypothesis, as being the begging of certain matters with a view to the establishment of another in question. Thus it is said that Democritus [1213] used a hypothesis, namely, that of atoms and a vacuum; and Asclepiades [1214] that of atoms [1215] and pores. Now, when applied to mathematics, the term hypothesis is to be taken in the third sense.That Pythagoras was not the only one who duly honoured arithmetic, but that his best known disciples did so too, being wont to say that "all things fit number." [1216]That arithmetic has as its immediate end chiefly the theory of science, [1217] than which there is no end either greater or nobler. And its second end is to bring together in one all that is found in determinate substance. [1218]Who among the mathematicians has made any discovery?Eudemus [1219] relates in his Astrologies that OEnopides [1220] found out the circle of the zodiac and the cycle [1221] of the great year. And Thales [1222] discovered the eclipse of the sun and its period in the tropics in its constant inequality. And Anaximander [1223] discovered that the earth is poised in space, [1224] and moves round the axis of the universe. And Anaximenes [1225] discovered that the moon has her light from the sun, and found out also the way in which she suffers eclipse. And the rest of the mathematicians have also made additions to these discoveries. We may instance the facts -- that the fixed stars move round the axis passing through the poles, while the planets remove from each other [1226] round the perpendicular axis of the zodiac; and that the axis of the fixed stars and the planets is the side of a pentedecagon with four-and-twenty parts.

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