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# Jacob Philipp Kulik and his Calendars

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**Abstract.** Jacob Philipp Kulik (1793–1863) was a mathematician and university professor, who taught at Lyceums in Olomouc and Graz and at the Prague University. He is known for his work in the number theory (especially his manuscript of extensive tables of prime numbers and divisors is well known).

The aim of this article is to present Kulik's calendars – the part of his work in which he joined his knowledge in astronomy and number theory. He participated in creating common diaries for one year – he prepared astromical and chronometrical information for them. He also published three editions of the universal calendar, which could be very useful for lawyers, historiographers and other people, who had to work with old manuscripts.

## Introduction

Jacob Philipp Kulik was born on 1st May 1793 in Lviv.[1] After finishing a grammar school he studied at the Faculty of Philosophy at the Lviv University.[2] Because his father wanted him to be a lawyer he started to study law, but he also studied mathematics at the same time. Without telling his parents he entered a competition for a position of a professor of elementary mathematics at the Lyceum in Olomouc.[3] He won this competition and although he was only 21 years old, he became a full professor at that lyceum in 1814.

In 1816 J. Ph. Kulik moved to Graz, where he taught physics at the lyceum[4] and later also astronomy at the Joanneum.[5] He obtained a doctorate in Philosophy by his thesis *De phaenomenis Iridis* and published his first books there.

In 1826 J. Ph. Kulik became a full professor of advanced matematics[6] at Prague University. He created the biggest part of his work in Prague and stayed there till his death. Despite teaching mathematics he substituted for astronomy teachers several times. He also worked in *Königliche böhmische Gesellschaft der Wissenschaften* [the Royal Bohemian Society of Sciences] and supported *Verein für freie Vortrage aus der Mathematik und Physik* [Association for Free Lectures on Mathematics and Physics].[7] Jacob Philipp Kulik died on 28th February 1863 in Prague.

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[1] Lviv (Ukrainian: *L'viv*, Polish: *Lwów*, German: *Lemberg*) is a big city in western Ukraine. It was founded in 1256 and it was a Polish city belonging to the Austrian Empire at the end of 18th century. See also http://www.city-adm.lviv.ua/.

[2] The university is now called *Ivan Franko National University of L'viv*. It was established by the Society of Jesus in 1661. See also http://www.lnu.edu.ua/general/about.htm.

[3] The Lyceum in Olomouc was a successor of the Olomouc University, which was established in 1569 by the Society of Jesus. In 1778, this university was moved to Brno, but it was returned and reduced to the lyceum in 1782. In 1827, it was renewed to the regular university. It is called *Palacký University Olomouc* today. More information about the history of mathematics at this university can be found in http://navarikp.sweb.cz.

[4] The Graz University was founded in 1585 by Archduke Charles II of Austria. It was reduced to lyceum in 1782 and renewed to the regular university in 1827. It is called *Karl-Franzens-Universität Graz* today. See also http://www.uni-graz.at/en/ains2www_geschichte/.

[5] Joanneum was founded by Archduke John of Austria in 1811. It was a technical school where physics, chemistry, astronomy, mineralogy, botany and technology were taught. It is called *Technische Universität Graz* today. See also http://en.wikipedia.org/wiki/Graz_University_of_Technology.

[6] The original German term is *Der ordentliche Professor der höheren Mathematik*.

[7] *Verein für freie Vortrage aus der Mathematik und Physik* was established in 1861. It was a predecessor of nowdays *Union of Czech Mathematicians and Physicists*. See also [*Bečvářová*, 2008].

Kulik's work can be divided into three main groups. The first group contains university textbooks[8] on mathematics and physics, which he recommended his students. The second group can be called applied mathematics. For example the calendars, which are the main topic of this article, belong to this group. Also his various tables intended to the technical practice are included in this group. The last group are the works on number theory. The biggest and well known part of this group is Kulik's extensive manuscript called *Magnus canon divisorum pro omnibus numeris per 2, 3 et 5 non divisibilibus et numerorum primorum interjacentium ad milies centena milia, accuratius ad 100330201 usque.* It contains tables of the smallest divisors in the range from 3 033 001 to 100 330 201.[9] He also published a few articles in mathematical journals (e.g. *Abhandlungen der königlichen böhmischen Gesellschaft der Wissenschaften* [Treatises of Royal Bohemian Society of Sciences] or *Zeitschrift für Physik und Mathematik* [Journal of Physics and Mathematics]). More information about Kulik's life and work can be found in [*Moravec*, 2009a, 2009c].

## One-year Calendars

The first part of Kulik's work on the chronometry is his participating on creating one-year calendars. These calendars were often published in the 19$^{\text{th}}$ century and used by common people. J. Ph. Kulik participated in a couple of these calendars – e.g. *Grosser Allgemeiner National-Kalender auf das Gemeinjahr 1822 für Katholiken, Protestanten und Griechen* [Big General National Calendar for the Ordinary Year 1822 for Catholics, Protestants and Greek Catholics] or *Vaterländischer Allgemeiner Schreib-Haus-Wirthschafts-Kalender für das Jahr 1853* [Homeland General Household Calendar for the Year 1853].

Such calendars are similar to present diaries but they are more comprehensive and contain much more additional information which is not necessary for us nowdays because of modern technologies such as internet or television. Each of them contains a diary-part in which the meetings, celebrations and other activities could be noted – it is similar to the present time diaries. However, the diary is only one part and takes about a half of such calendar.

There are lists of various actions for the whole year as well – fairs, markets, celebrations, religious holidays etc. In addition, we can find there many astrologic prognoses and weather lores. Moreover, medical and herbalist's advice for home treatment of several illnesses are metioned there and also some short stories, usually with funny pictures are added.

One part of these calendars is usually dedicated to astronomy and just this is Kulik's own work. There are lists of astronomical phenomena such as full moons, solar and moon eclipses, stars movements etc. The astronomical processes are also explained in some of these calendars. Kulik probably participated also in creating the diaries and in stating dates of religious holidays.

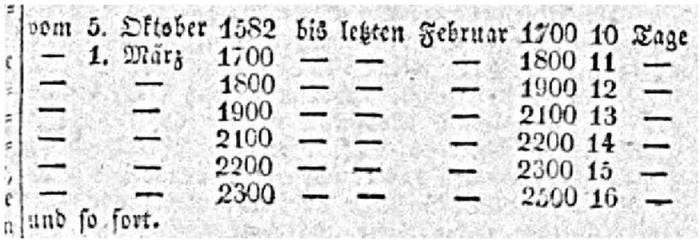
These calendars are really not scientific work, but it is very interesting that a university professor worked on such books. Maybe, his name written on the title page was a good promotion for these products at that time.

## Universal Calendars

J. Ph. Kulik published three editions of the universal calendar [*Kulik*, 1831, 1843, 1861]. The first and the second edition are titled *Der tausendjährige Kalender* [Thousand-Year Calendar]. There is one big difference between these two editions – the first edition contains only Christian calendars, but in the second one Jewish and Islamic calendars are added. The third edition was reduced and renamed to *Die Jahresformen der Christlichen Zeitrechnung* [Year-Forms of the Christian era]. Before we have a look at them we should mention some basic historical facts connected with the development of Christian calendars.

[8] E.g. Kulik J. Ph.: Lehrbuch der höheren Analysis, Prague, 1831. Second edition, Prague, 1843.

[9] More information about Kulik's tables can be found in [*Nový*, 1981] and [*Moravec*, 2009b].



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| vom | 5. Oktober | 1582 | bis | letzten | Februar | 1700 | 10 | Tage |
| — | 1. März | 1700 | — | — | — | 1800 | 11 | — |
| — | — | 1800 | — | — | — | 1900 | 12 | — |
| — | — | 1900 | — | — | — | 2100 | 13 | — |
| — | — | 2100 | — | — | — | 2200 | 14 | — |
| — | — | 2200 | — | — | — | 2300 | 15 | — |
| — | — | 2300 | — | — | — | 2500 | 16 | — |
| und so fort. | | | | | | | | |

**Figure 1.** The table from the second edition of Kulik's universal calendar shows the growing differences between Julian and Gregorian calendar.

### Historical Development of Christian Calendars

There are two Christian calendars – Julian and Gregorian. Julian calendar was developed by Julius Caesar in 46 B.C. as a replacement of older ancient calendars. It has the same number of days in months as we use nowadays but there was only simple rule for leap years – every fourth year is leap. In 325, this calendar was established by the First Council of Nicaea as the calendar for the whole Christian world. It was quite inaccurate – the tropical year lasts 365 days, 5 hours, 48 minutes and 48 seconds,[10] but the year created by this calendar lasts 365 days and 6 hours. Religious holidays like Easter were delayed more and more.

To avoid this delay a new calendar was developed. It was the one which we use today and which we call Gregorian calendar. On 24$^{th}$ February 1582 the Pope Gregory XIII established this calendar by the bull *Inter gravissimas*. He requested that Thursday 4$^{th}$ October 1582 (by the old calendar) will be followed by Friday 15$^{th}$ October 1582 (by the new calendar). The calendar was accepted in Catholic countries such as Italy or Spain, but many Christian countries accepted it later (e.g. Czech countries in 1587) and Orthodox Church has never accepted it. The differences between Julian and Gregorian calendar could cause many problems with old documents dating and Kulik's universal calendars were intended to solve such problems.

### Using of Kulik's Universal Calendars

Kulik prepared his universal calendars for people who didn't have advanced knowledge in mathematics. No or only a few basic mathematic operations were needed for using them.

The most common way of use is to search the right calendar for given year. There are 35 variants of Christian calendars – we need to search the proper one. Kulik prepared a table which made the searching very easy. The header of this table and the part with the year 2010 are shown in Figure 2.

The first column indicates the year we are searching for. In the second one we can find the number of variant for Julian and Gregorian calendar. In case the picture is from the second edition there are also other columns with information necessary for searching the proper Jewish or Islamic calendar corresponding with the year written in the first column. If we find out the year 2010 we will see that for Julian calendar we should use the variant number 32 and for Gregorian calendar number 4.

As we can see in Figure 3, the number 4 is really right variant for 2010. An interesting fact is the duplicity of January and February (first pair for a leap year, second pair for a common year). This space-saving system allows using each variant for both leap and common year. Religious holidays are stated in these calendars, so the system of variants calculates also with astronomic situations which determines these feasts.

Although religious holidays are in all calendar variants, Kulik added some simple algorithms

[10] Tropical year is the length of time that the Sun takes to return to the same position in the cycle of seasons, as seen from the Earth; so it is a 'year'. See also http://en.wikipedia.org/wiki/Tropical_year.

| Jahr Christi. | Alter Kalen. | Neuer Kalen. | Jüdisches Neujahr. | Jüd. Kal. | Türkisches Neujahr. | Türk. Kal. |
|---|---|---|---|---|---|---|
| 2008* | 14 33 | 30 | 5769 | 11 4 | 9 | 1429 | 1 8 4 |
| | | | | | 28 ☽ | 1430 | 35 7 1 |
| 2009 | 6 12 | 19 | 5770 | 26 4 | 17 | 1431* | 34 6 5 |
| 2010 | 32 4 | 9 | 5771 | 50 7 | 7 | 1432 | 33 6 3 |
| 2011 | 11 24 | 29 | 5772 | 15 3 | 26 ☾ | 1433 | 32 5 7 |
| 2012* | 2 8 | 17 | 5773 | 2 1 | 14 | 1434* | 31 3 4 |
| 2013 | 22 31 | 5 | 5774 | 50 3 | 4 | 1435 | 30 3 2 |
| 2014 | 7 20 | 25 | 5775 | 14 9 | 24 ☽ | 1436* | 29 2 6 |
| 2015 | 30 5 | 14 | 5776 | 47 4 | 14 | 1437 | 28 2 4 |
| 2016* | 18 27 | 3 ☽ | 5777 | 3 7 | 2 | 1438 | 27 0 1 |

**Figure 2.** Table of calendars corresponding with particular years (from the second edition).

4. Jahresform.

Im Schaltjahre DC — Im Gemeinjahre C.

| Jäner | Februar. | Jäner. | Februar. | März. | April. | Mai. |
|---|---|---|---|---|---|---|
| D. 1 *Beneh. Chr.* | S. 1 *Sept.* Ignaz | F. 1 *Beneh. Chr.* | M. 1 Ignaz M. | M. 1 Albin | D. 1 Gründonn. | S. 1 Phil. u. Jak. |
| F. 2 Makarius | M. 2 *Mar. Rein.* | S. 2 Makarius | D. 2 *Mar. Rein.* | D. 2 Simpliz | F. 2 Charfreitag | S. 2 *Cant.* Sigis. |
| S. 3 Genovefa | D. 3 Blasius B. | S. 3 Genovefa | M. 3 Blasius B. | M. 3 Kunigunde | S. 3 Charsamst. | M. 3 Kreuzerfind. |
| S. 4 Titus Bisch. | M. 4 Veronika | M. 4 Titus Bisch. | D. 4 Veronika | D. 4 Kasimir | S. 4 **Ostern** | D. 4 Florian |
| M. 5 Telesphor | D. 5 Agatha | D. 5 Telesphor | F. 5 Agatha | F. 5 Fried. Adc. | M. 5 *Ostermont.* | M. 5 Gotthard |
| D. 6 *Heil. 3 Kön.* | F. 6 Dorothea | M. 6 *Heil. 3 Kön.* | S. 6 Dorothea | S. 6 Toleta J. | D. 6 Cölestin | D. 6 Joh. v. Pf. |
| M. 7 Lucian | S. 7 Romuald | D. 7 Lucian | S. 7 *Sex.* Rom. | S. 7 *Oculi* Tho. | M. 7 Herrmann | F. 7 Stanisl. B. |
| D. 8 Erhard | S. 8 *Sex.* Johann | F. 8 Erhard | M. 8 Joh. v. M. | M. 8 Joh. v. G. | D. 8 Albert | S. 8 Michael |
| F. 9 Basilisse | M. 9 Apollonia J. | S. 9 Basilisse | D. 9 Apollonia J. | D. 9 *Cyr. Meth.* | F. 9 Kleophas | S. 9 *Roy.* Gregor |
| S. 10 Agathon | D. 10 Scholastika | S. 10 (1) n. Ersch. | M. 10 Scholastika | M. 10 40 Märt. | S. 10 Ezechiel | M. 10 Gordian |
| S. 11 (1) n. Ersch. | M. 11 Euphrosina | M. 11 Hygin | D. 11 Euphrosina | D. 11 Konstantin | S. 11 *Quas.* Leo P. | D. 11 Mamert |
| M. 12 Probus | D. 12 Eulalia | D. 12 Prob. Ernest | F. 12 Eulalia | F. 12 Gregor P. | M. 12 Julius | M. 12 Pankraz |
| D. 13 Leontius | F. 13 Jordan | M. 13 Leontius | S. 13 Jordan Jul. | S. 13 Rosina | D. 13 Hermeneg. | D. 13 *Chr. Himf.* |
| M. 14 Hilarius | S. 14 Valentin | D. 14 Hilarius | S. 14 *Quinq.* Val. | S. 14 *Laet.* Mathil. | M. 14 Tiburz | F. 14 Bonifaz |
| D. 15 Paul Einsied. | S. 15 *Quinq.* Fau. | F. 15 Paul Eins. | M. 15 Faustin | M. 15 Longin M. | D. 15 Theodor | S. 15 Sophie |
| F. 16 Marcell P. | M. 16 Juliana | S. 16 Marcell P. | D. 16 Juliana J. | D. 16 Patriz | F. 16 Kalixt | S. 16 *Joh. v. Nep.* |
| S. 17 Anton Eins. | D. 17 Simeon B. | S. 17 *Namen Jesu* | M. 17 Aschermitt. | M. 17 Gertraud | S. 17 Rudolph | M. 17 Torpes |
| S. 18 *Namen Jesu* | M. 18 Aschermittw. | M. 18 Priska J. | D. 18 Mansuet | D. 18 Heribert | S. 18 *Mis.* Wern. | D. 18 Venanz |
| M. 19 Ferdinand | D. 19 Konrad | D. 19 Ferd. Kanut | F. 19 Konrad | F. 19 *Joseph Pfl.* | M. 19 Kres. Mar. | M. 19 Peter Cölest. |
| D. 20 Fab. u. Seb. | F. 20 Eleuther | M. 20 Fab. u. Seb. | S. 20 Eleuther | S. 20 Joachim | D. 20 Sulpiz | D. 20 Bernardin |
| M. 21 Agnes | S. 21 Eleonora | D. 21 Agnes J. | S. 21 *Quad.* Eleo. | S. 21 *Jud.* Bened. | M. 21 Anselm | F. 21 Felix Cant. |
| D. 22 Vinc. u. Anast. | S. 22 *Quad.* Pet. | F. 22 Vinc. u. Anast. | M. 22 Pet. Stulf. | M. 22 Oktavian | D. 22 Sot. u. Kaj. | S. 22 Julie |
| F. 23 Mariä Verm. | M. 23 Eberhard | S. 23 Mar. Verm. | D. 23 Eberhard | D. 23 Otto | F. 23 Adalbert | S. 23 **Pfingsten** |
| S. 24 Timotheus B. | D. 24 Schalttag | S. 24 (3) n. Ersch. | M. 24 Math. Ap. *F.* | M. 24 Gabriel Erz. | S. 24 Georg M. | M. 24 *Pfingstmon.* |
| S. 25 (3) n. Ersch. | M. 25 Math. A. *F.* | M. 25 Pauls Bekeh. | D. 25 Walburga J. | D. 25 *Mar. Verk.* | S. 25 *Jub.* Mark E. | D. 25 Urban P. |
| M. 26 Polykarp | D. 26 Walburga | D. 26 Polykarp | F. 26 Alexander *F.* | F. 26 Kastulus | M. 26 Klet. u. M. | M. 26 Phil. N. *F.* |
| D. 27 Joh. Chrys. | F. 27 Alexander *F.* | M. 27 Joh. Chryso | S. 27 Leander *F.* | S. 27 Rupert | D. 27 Anastas | D. 27 Magd P. |
| M. 28 Karl d. Gr. | S. 28 Leander | D. 28 Karl d. Gr. | S. 28 *Rem.* Rom. | S. 28 *Palm* Guntr. | M. 28 Vital | F. 28 Ivo u. P. *F.* |
| D. 29 Franz Sal. | S. 29 *Rem.* Rom. | F. 29 Franz Sal. | | M. 29 Eustach | D. 29 Peter M. | S. 29 Maximus *F.* |
| F. 30 Martina J. | | S. 30 Martina J. | | D. 30 Quirin | F. 30 Kathar. S. | S. 30 *Heil. Dreif.* |
| S. 31 Peter Nol. | Fasching 6 W. 1 Tag | S. 31 *Sept.* Pet. N. | Fasching 6 Wochen. | M. 31 Guido | | M. 31 Petronille |

| Juni. | Juli. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|
| D. 1 Fortunat | D. 1 Theodorich | S. 1 (10) Pet. K. | M. 1 Egidius | F. 1 Remigius | M. 1 *Aller Heil.* | M. 1 Eligius |
| M. 2 Erasmus | F. 2 Kamillus | M. 2 Stephan P. | D. 2 Steph. Emr. | S. 2 Leodegar | D. 2 Aller Seel. | D. 2 Bibiana |
| D. 3 **Fronl.** | S. 3 Heliodor | D. 3 Steph. Erf. | F. 3 Mansuet | S. 3 (19) Candid. | M. 3 Hubert | F. 3 Franz Xav. |
| F. 4 Optatus | S. 4 (6) *Maria H.* | M. 4 Dominik | S. 4 Rosalia J. | M. 4 Franz Ser. | D. 4 Karl Bor. | S. 4 Barbara |
| S. 5 Bonifaz | M. 5 Domitius | D. 5 Maria Schn. | S. 5 *Schutzengl.* | D. 5 Placidus | F. 5 Emmerich | S. 5 Judith |
| S. 6 (2) Norbert. | D. 6 Isajas Pr. | F. 6 Verkl. Chr. | M. 6 Zacharias | M. 6 Bruno | S. 6 Leonard | M. 6 Nikolaus B. |
| M. 7 Robert | M. 7 Willibald | S. 7 Kajetan | D. 7 Regina | D. 7 Justina J. | S. 7 (24) Engelb. | D. 7 Ambros. |
| D. 8 Medard | D. 8 Kilian | S. 8 (11) Cyriak | M. 8 *Mar. Geb.* | F. 8 Brigitte J. | M. 8 Gottfried | M. 8 *Mar. Empf.* |
| M. 9 Prim. u. Fel. | F. 9 Brictius | M. 9 Roman | D. 9 Gorgon | S. 9 Dionys | D. 9 Theodor | D. 9 Leokadia |
| D. 10 Oliva J. | S. 10 7 Brüder M. | D. 10 Laurenz | F. 10 Nikol. Tol. | S. 10 (20) Franz B. | M. 10 Gregor | F. 10 Melchiad |
| F. 11 Barnabas | S. 11 (7) Pius P. | M. 11 Susanna | S. 11 Paphnuz B. | M. 11 Emilian | D. 11 Martin B. | S. 11 Damasus |
| S. 12 Basilides | M. 12 Joh. Gualb. | D. 12 Klara J. | S. 12 *Nam. Mar.* | D. 12 Maximilian | F. 12 Martin P. | S. 12 Synesius |
| S. 13 (3) Ant. v. P. | D. 13 Margareth | F. 13 Hypolit | M. 13 Tobias | M. 13 Koloman | S. 13 Stanisl. K. | M. 13 Lucia J. |
| M. 14 Basilius | M. 14 Bonaventura | S. 14 Eusebius | D. 14 Kreuzerhöh. | D. 14 Burghard | S. 14 (25) Serap. | D. 14 Nikasius |
| D. 15 Veit M. | D. 15 Apst. T. Hein | S. 15 *Mar. Himf.* | M. 15 Nikodem *F.* | F. 15 Theresia | M. 15 *Leopold* | M. 15 Irenäus *F.* |
| M. 16 Benno B. | F. 16 Faust Ange. | M. 16 Rochus | D. 16 Ludmilla | S. 16 Gallus Abt. | D. 16 Ottomar | D. 16 Albina |
| D. 17 Adolph | S. 17 Alexius | D. 17 Liberat | F. 17 Lamb. B. *F.* | S. 17 (21) Hedwig | M. 17 Gregor T. | F. 17 Lazar *F.* |
| F. 18 Marzell M. | S. 18 (8) Symph. | M. 18 Helena K. | S. 18 Thom. B. *F.* | M. 18 Lukas Ev. | D. 18 Odon | S. 18 Grazian *F.* |
| S. 19 Gerv. u. P. | M. 19 Arsenius | D. 19 Ludov. Tol. | S. 19 (17) Sebald | D. 19 Peter Alk. | F. 19 Elisabeth | S. 19 Nemesius |
| S. 20 (4) Silv. P. | D. 20 Elias Proph. | F. 20 *Stephan K.* | M. 20 Eustach | M. 20 Wendelin | S. 20 Felix Val. | M. 20 Christina |
| M. 21 Aloys Gonz. | M. 21 Daniel Pr. | S. 21 Anastas | D. 21 Math. Ap. | D. 21 Ursula | S. 21 (26) Mar. O. | D. 21 Thomas Ap. |
| D. 22 Achaz | D. 22 Mar. Magd. | S. 22 (13) Timot. | M. 22 Mauriz | F. 22 Kordula | M. 22 Cäcilia J. | M. 22 Zeno |
| M. 23 Edeltrud | F. 23 Apollinar | M. 23 Philipp Ben. | D. 23 Thekla J. | S. 23 Sever. | D. 23 Klemens P. | D. 23 Victoria |
| D. 24 Johann T. | S. 24 Christine | D. 24 Barthol. Ap. | F. 24 Gerhard | S. 24 (22) Raph. E. | M. 24 Chrysogon | F. 24 Adam u. Eva |
| F. 25 Ivan Sid. | S. 25 (9) Jak. Ap. | M. 25 Ludwig K. | S. 25 Kleophas | M. 25 Krisp. u. K. | D. 25 Katharina | S. 25 **Geb. Chr.** |
| S. 26 Joh. u. Paul | M. 26 Anna | D. 26 Zephyrin | S. 26 (18) Cyp. J. | D. 26 Evarist | F. 26 Konrad | S. 26 *Stephan M.* |
| S. 27 (5) Ladislaus | D. 27 Pantaleon | F. 27 Joseph Kal. | M. 27 Kosm. u. D. | M. 27 Sabina | S. 27 Virgil | M. 27 Johann Ev. |
| M. 28 Leo P. | M. 28 Innocenz S. | S. 28 Augustin | D. 28 *Wenceslaus* | D. 28 Sim. u. Ju. | S. 28 Adventsonnt. | D. 28 Unsch. Kind. |
| D. 29 *Pet. u. Paul.* | D. 29 Martha | S. 29 (14) Joh. E. | M. 29 *Michael E.* | F. 29 Narciss | M. 29 Saturnin | M. 29 Thomas B. |
| M. 30 Pauls Ged. | F. 30 Abdon. u. S. | M. 30 Rosa J. | D. 30 Hieronymus | S. 30 Marcell | D. 30 Andreas Ap. | D. 30 David K. |
| | S. 31 Ignaz Lojol. | D. 31 Raymund | | S. 31 (23) Wolfg. | | F. 31 Sylvester |

**Figure 3.** The variant of Christian calendar number 4 (from the third edition).

to state them without calendars. We mention two of them which could be used for calculating the date of Easter Sunday. The first algorithm is based on work with epacts, Dominical letters and

| G. Zahl: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Epakte: | 16 | 27 | 8 | 19 | 0 | 11 | 22 | 3 | 14 | 25 | 6 | 17 | 28 | 9 | 20 | 1 | 12 | 23 | 4 |

| Jahrhunderte addit. | Jahrhunderte subtrakt. | Korrektion |
|---|---|---|
| 15, 16 | 85, 86 | 15 |
| 17, 18, 87, 88, 89 | 82, 83, 84 | 14 |
| 19, 20, 21 | 79, 81 | 13 |
| 22, 24 | 78, 80 | 12 |
| 23, 25 | 75, 76, 77 | 11 |
| 26, 27, 28 | 73, 74 | 10 |
| 29, 30 | 70, 71, 72 | 9 |
| 31, 32, 33 | 67, 69 | 8 |
| 34, 36 | 66, 68 | 7 |
| 35, 37 | 63, 65 | 6 |
| 38, 39, 40 | 62, 64 | 5 |
| 41 | 58, 60, 61 | 4 |
| 42, 43, 44 | 57, 58 | 3 |
| 45, 46 | 54, 55, 56 | 2 |
| 47, 48, 49 | 51, 53 | 1 |

**Figure 4.** Tables of epacts and their corrections (from the first edition).

| | E | g | f | e | d | c | b | a |
|---|---|---|---|---|---|---|---|---|
| J. 17. 18. 87 | 30 | 15 | 14 | 20 | 19 | 18 | 17 | 16 |
| 62. 64 | 11 | 8 | 7 | 6 | 5 | 4 | 3 | 9 |
| 35. 37 | 22 | 35 | 34 | 33 | 29 | 28 | 27 | 26 |
| 79. 81 | 3 | 15 | 14 | 13 | 12 | 11 | 17 | 16 |
| 54. 55. 56 | 14 | 1 | 31 | 6 | 5 | 4 | 3 | 2 |

**Figure 5.** A part of Easter table (from the first edition).

golden numbers, the second one is Gauss's algorithm.[11] To make the using of these algorithms as simple as possible Kulik prepared some additional tables.

The golden number is the remainder after division the year number by 19 which is increased by 1 (for 2010: 16). It categorizes years by lunar phases. The epact is the age of the moon on 1st January.[12] The Dominical letter is a letter which will be associated with the first Sunday of the year, if we subsequently sign first seven days of the year with letters $A$–$G$ (for 2010: $C$). If we have the golden number and the Dominical letter for our year, we can find the epact in the table. When epacts need to be corrected in Gregorian calendar, Kulik also added a table with such corrections. Both tables are shown in Figure 4.

The epact for the golden number 16 is 1. When the year number begins with 20, the correction is 13 and the sum of the epact and its correction is 14. Now we have a look into the Easter table (Figure 5) and for the epact 14 (last row) and Dominical letter $C$ we will find the number 4 which means that Easter Sunday is on 4th April (in the year 2010).

Gauss's algorithm needs more calculation then the previous one. Firstly, we need to count remainders after division the year number by 19, 4 and 7 and call them $a$, $b$ and $c$ (for 2010: $a = 15$, $b = 2$, $c = 1$). Then we need to know numbers $m$ and $n$, which differs for each century.

[11] Johann Carl Friedrich Gauss (1777–1855) was a well known German mathematician and physicist interested in number theory, statistics, analysis, differential geometry, geodesy, geophysics, electrostatics and astronomy. The Easter algorithm was mentioned in Gauss C. F., Berechnung des Osterfestes, *Monatliche Correspondenz zur Befrderung der Erd- und Himmls-Kunde 2*, August 1800, 121–130. More information can be found e.g. in Dunnington G. W., Carl Friedrich Gauss: Titan of Science, New York, 2003.

[12] See also http://www.newadvent.org/cathen/05480b.htm.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
| m. | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 26 | 25 | 26 | 27 | 27 | 27 | 28 | 28 | 29 |
| n. | 2 | 3 | 4 | 5 | 5 | 6 | 0 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 0 |

**Figure 6.** A part of table of numbers $m$, $n$ (from the first edition).

When the year begins with 20 we can find in the table (Figure 6) that these numbers are $m = 24$ and $n = 5$.

Now, we can calculate the numbers $d = (19a + m) \bmod 30$ (for 2010: $d = 9$) and $e = (n + 2b + 4c + 6d) \bmod 7$ (for 2010: $e = 4$). Then we sum $22 + d + e$. If we call the result $x$, then Easter Sunday is on $x^{\text{th}}$ March. If $x$ is higher then 31, the Easter Monday is on $(x - 31)^{\text{th}}$ April (for 2010: on $4^{\text{th}}$ April).

These two algorithms are only illustration of many additional algorithms and tables that J. Ph. Kulik showed in his universal calendars. He described methods for dating some other religious holidays, astronomical phenomena etc. This additional information is only in first two editions, the last one was strongly reduced.

## Conclusion

Although this part of Kulik's work does not include any new mathematical results, it could be very useful to many people in the $19^{\text{th}}$ century, who worked as judges, lawyers or historians. It is also fascinating that it still works without any mistake.

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