

Appendix 4 — Archaeoastronomy Methodologies applied to an Investigation of the fresco scheme of the Salone, Palazzo della Ragione, Padua, Italy.¹

As has been noted in an earlier chapter, the Palazzo della Ragione was built with a trapezium shape and offset to the urban architecture surrounding it. These fieldwork notes acknowledge that the rhomboid shape of the building was laid down when the Palazzo della Ragione was first constructed in 1218-1219. They take into account the understanding that religious architecture was often aligned with seasonal phenomena and investigate whether the same methodology can be applied to the Palazzo della Ragione. The research considers the alignment of the long axis with the equinoctial spring full moon and the theological implications this may have in connection with Easter. The research then discusses how the external orientation of the Palazzo della Ragione might have impacted on the design and layout of the internal fresco scheme of the Salone situated on its first floor when it was painted a century later.

Introduction

Customary fields of study in the application of archaeoastronomy methodologies are centred around the structures of temples and communal tombs of the Neolithic, Chalcolithic and Bronze Ages. Ivan Šprajc points out that many of these structures have been built so that they faced the sun when it was rising.² Michael Hoskin suggests that such structures may have looked towards a mountain peak that housed a sanctuary sacred to a lunar goddess.³ Closer to us in time, research conducted on medieval (seventh to early twelfth century) Christian churches in western Europe, with exceptions in Italy, indicate that they are broadly aligned east, aligned with sunrise on the feast day of the

¹ This research has benefited greatly from the advice, help and suggestions of Fabio Silva, particularly with regard to the concept of the equinoctial full moon.

² Ivan Šprajc, 'Astronomical and cosmological aspects of Maya architecture and urbanism', in *Cosmology Across Cultures, Astronomical Society of the Pacific Conference Series*, ed. José Alberto Rubiño-Martin, et al. Vol. 409 (San Francisco: 2009), 303-314.

³ Michael Hoskin, *Tombs, Temples and Their Orientations: A New Perspective on Mediterranean Prehistory* (Bognor Regis: Ocarina Books Ltd, 2001), p.222.

saint to whom they were originally dedicated,⁴ aligned to a solstice axis,⁵ aligned to the sunrise horizon point for the day the foundations were prepared,⁶ or aligned to the first day of May.⁷ Other studies, such as that carried out by Saša Čaval on the astronomical orientations of sacred architecture during the medieval period in Slovenia, show that Romanesque churches are generally aligned to sunrises and sunsets on Christian feasts that were particularly important in that period.⁸ Čaval also found that whilst there was some correspondence of orientations to patron saints, this was not a dominant practice. Laura Jacobus draws attention to the fact that, on the Feast of the Annunciation (25 March), a single ray of sun finding its way through the tracery of the window of the Arena Chapel in Padua, Italy, just before ten o'clock in the morning, casts its light directly onto the west wall (Fig.1) where the fresco depicts the owner and commissioning patron Enrico Scrovegni making an offering of a small painted version of the Arena Chapel to the Virgin Mary (Fig.2).⁹ The light beam falls on the wall between Scrovegni's extended hand and the Virgin and appears to enter the doorway of the painted chapel he presents to her, suggesting that the chapel receives the sun on the Feast of the Annunciation. This is a direct quotation of medieval painted images of The Annunciation, that moment in time when the Virgin Mary receives the light of impregnation once the angel Gabriel announced that she would conceive and become the mother of Christ, this time using the light of the actual sun. However, what of civic buildings? Was there the same necessity to orient buildings towards a particular position and if so, why?

⁴ Manuela Incerti, 'Architettura e cosmo attraverso gli strumenti della scienza della rappresentazione./Architecture and the Universe, Representation as a study tool', *Disegnare. Idee e Immagini* 32(2006), 82-91, p.90.

⁵ Bernadette Brady, 'Chartres Cathedral and the role of the Sun in the Cathedral's Christian Platonic Theology', in *Sky and Psyche*, ed. N. Campion and P. Curry (Edinburgh: Floris Books, 2006), 59-76, pp.71-73.

⁶ Ibrahim Allawi, 'Some Evolutionary and Cosmological Aspects to Early Islamic Town Planning', ed. Margaret Bentley Sevcenko, (Cambridge, Massachusetts: Aga Khan Program for Islamic Architecture, 1988; http://archnet.org/library/documents/one-document.jsp?document_id=3776).

⁷ Peter G. Hoare and Caroline S. Sweet, 'The orientation of early medieval churches in England', *Journal of Historical Geography* 26, no. 2 (2000), 162-173, p.162.

⁸ Saša Čaval, 'Astronomical Orientations of Sacred Architecture during the Medieval Period in Slovenia', in *Cosmology Across Cultures, Astronomical Society of the Pacific Conference Series*, ed. José Alberto Rubiño-Martin, et al. Vol. 409 (San Francisco: 2009), 209-218, pp.210-211.

⁹ Laura Jacobus, *Giotto and the Arena Chapel* (London: Harvey Miller Publishers, 2008), pp.326-329, 416.

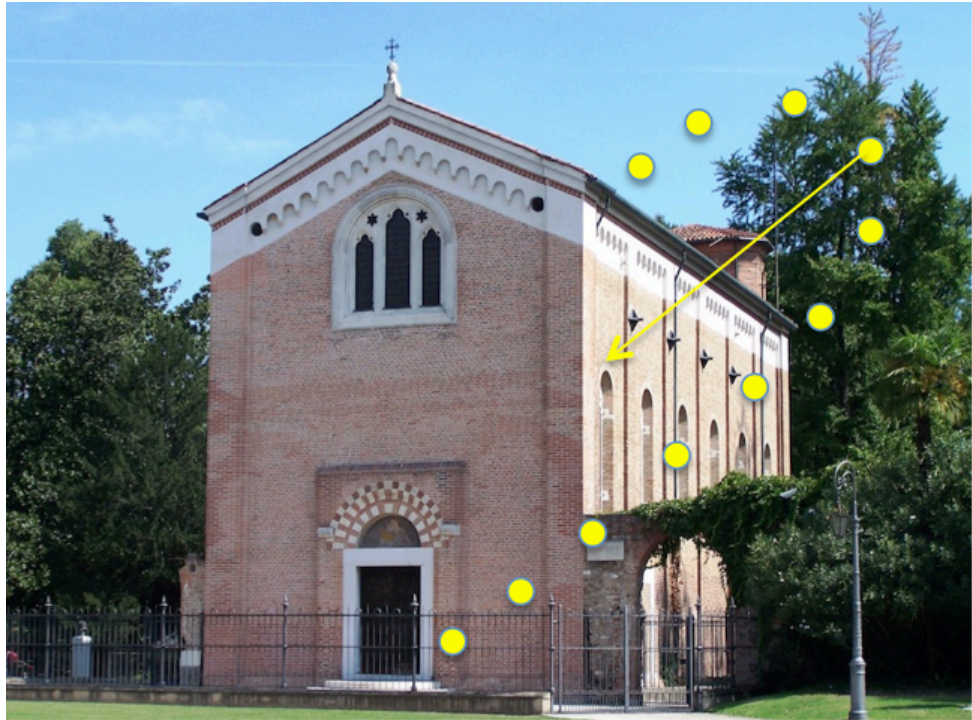


Figure 1. Exterior Arena Chapel, Padua, Italy, showing the passage of the sun on 25 March and the beam of light passing through tracery on the south wall. Not to scale. *Photo of Arena Chapel*: Wikimedia Commons.



Figure 2. The passage of the sunbeam on the Feast of The Annunciation, 25 March, west wall, Arena Chapel, Padua, Italy. Photo from: Jacobus, Laura. *Giotto and the Arena Chapel*. London: Harvey Miller Publishers, 2008, p.416.

The Cosmological Building

Research carried out by Giorgetta Bonfiglio-Dosio regarding the Paduan municipal archives revealed that the first *statutorum corpus*, dated to around 1260, was the only historical source on the rules concerning municipal life and institutions before 1420.¹⁰ Thus although there appear to be no original documents regarding why the Palazzo della Ragione was built in a particular orientation, chronicles, annals and statutes recorded that the building was initially constructed during the communal *podestà* government of Giovanni Rusconi (1218) and completed under the communal *podestà* government of Malpilio da San Miniato (1219).¹¹ In order to make room for the original Palazzo della Ragione building and create a place large enough to contain meetings of the 400 strong *Consiglio Maggior* (Great Council) and other legal committees (as well as to accommodate urban necessities such as the prison), the commune dispossessed the old magnate Manfredi family of ownership of their property.¹² They purchased the tower that guarded the adjoining Palazzo del Consiglio from the aristocratic Camposampiero family.¹³ Finally they cleared an area of land within the city buildings, taking enough land to the north and south of the Palazzo della Ragione to create the Piazza dei Frutti and the Piazza del'Erbe and to provide space for market stalls. From such evidence one can conclude that the commune constructed the building on newly-cleared space and thus were able to choose its orientation and shape (Fig.3).

When the Palazzo della Ragione was expanded and reconstructed a century after it was first built, in 1306-09, the Paduans retained the building's original plan — trapezium in shape and offset to the surrounding city plan.¹⁴ However, the maintained shape and

¹⁰ Giorgetta Bonfiglio-Dosio, *La politica archivistica del Comune di Padova dal XIII al XIX secolo* (Roma: Editore Viella, 2002). Giorgetta Bonfiglio-Dosio, 'Padua Municipal Archives from the 13th to the 20th Centuries: A Case of a Record-keeping System in Italy', *Archivaria, North America* 60(Sept 2006), 91-104, p.92.

¹¹ Giovanni Fabris, *Cronache e Cronisti Padovani* (Cittadella: Rebellato Editore, 1977), p.369. Sante Bortolami, '«Spaciosum, immo speciosum palacium» Alle origini del Palazzo della Ragione di Padova', in *Il Palazzo della Ragione di Padova, La storia, l'architettura, il restauro*, ed. Ettore Vio (Padova: Signum Padova Editrice, 2009), p.39.

¹² Tim Benton, 'The Three Cities Compared: urbanism', in *Siena, Florence and Padua: Art, Society and Religion 1280-1400, Volume 2: Case Studies*, ed. Diana Norman. Vol. II - Case Studies (New Haven and London: Yale University Press in association with the Open University, 1995), 7-28, p.19. Giulio Bresciani Alvarez, 'Il Palazzo della Ragione: La Storia di Una Fabbrica Civile', in *Il Palazzo della Ragione in Padova*, ed. Pier Luigi Fantalli and Franca Pellegrini (Verona: Cierre Edizioni, 2000), p.4. M. Beatrice Rigobello and Francesco Autizi, *Palazzo della Ragione di Padova. Simbologie degli Astri e Rappresentazioni del Governo*. (Padova: Il Poligrafo, 2008), p.45.

¹³ Benton, 'The Three Cities Compared: urbanism', pp.19-20.

¹⁴ Colin Cunningham, 'For the honour and beauty of the city: the design of town halls', in *Siena, Florence*

orientation of the Palazzo della Ragione has posed a dilemma for modern scholars. In 1995 Colin Cunningham suggested that it pointed to the importance of tradition within the fourteenth-century Paduan commune where they wished to retain the original orientation without necessarily any understanding of what that orientation implied.¹⁵ In the same year Tim Benton, basing his arguments on the work of R. Cessi, speculated that the atypical orientation and plan form of the building may have been due to the layout of the houses and streets that were cleared in the area around it.¹⁶ Benton offered further conjecture based on the work of A. Prosdocimi and the work of L. Puppi and M. Universo, when he noted that the trapezium shape and ‘the use of bold stone arches facing a newly enlarged open space’ may also have been deliberately designed to evoke a Roman forum.¹⁷ Cunningham suggested the shape may have been due to it following an ancient watercourse that ran along the south side of the Piazza dei Frutti.¹⁸ Without original documentation, however, one can only infer such matters.



Figure 3. The Palazzo della Ragione from Google Earth showing the trapezium shape of the building and its offset nature to the surrounding street plan. North is at the top of the image.

and Padua: Art, Society and Religion 1280-1400, ed. Diana Norman, 2 vols. Vol. II: Case Studies (New Haven and London: Yale University Press in association with the Open University, 1995), 52-53, pp.51, 53.

¹⁵ Cunningham, ‘For the honour and beauty of the city: the design of town halls’, p.49.

¹⁶ Benton, ‘The Three Cities Compared: urbanism’, p.20. R. Cessi, ‘Le prime sedi comunali padovane’, *Bolletino del Museo Civico di Padova* 53(1964), 345-380., pp.345-380.

¹⁷ Benton, ‘The Three Cities Compared: urbanism’, p.21. A. Prosdocimi, ‘Note su Fra Giovanni degli Ermitani’, *Bolletino del Museo Civico di Padova* 52, no. 1 (1963), 15-61, pp.15-61. L. and Universo Puppi, M., *Le città nella storia d'Italia. Padova* (Bari: Laterza, 1982), p.63.

¹⁸ Cunningham, ‘For the honour and beauty of the city: the design of town halls’, p.49.

The search for a map

One such original document would be a map of the Palazzo della Ragione at the time of its initial construction showing urban landscape and topography. According to P.D.A. Harvey, medieval Europe was a society that was unversed in the knowledge of maps, which he defined as a drawing that indicated ‘some topographical relationship —the way from one place to another, the layout of fields, the sequence of houses in a street’.¹⁹ Harvey offered the idea that, since extremely few local maps survived from medieval England — three from the mid-twelfth to the mid-fourteenth century, ten between 1350-1500 and approximately two hundred from 1500-1550 — this was evidence that valuing landscape objects in this way was atypical to the thinking of the medieval mindset. Harvey went on to note that the more consistent way of denoting such features in these time periods was by way of written descriptions, such as itineraries, urban surveys, and field terriers — detailed descriptions of a scattered holding naming the area, each field, furlong, and the neighbours. Even though Roman surveyors from the first to the third century CE knew of and used scale — ‘the observance of a fixed proportion between distances on the map and distances on the ground’²⁰ — what survived as medieval ‘maps’ were pictorially drawn details of a town seen in birds-eye view and drawn as a stylized illustration within city walls with towers and buildings inside. Pierre Lavedan defined this as the city ideogram (‘l’idéogramme urbaine’)²¹ and at least two of these exist for Padua: a model of the city, sculpted by Andriolo de’Santi (c.1320–1375), originally part of the tomb of Ubertino da Carrara c.1350 and placed at the feet of his effigy (Fig.4); and the fresco painted by Giusto de’Menabuoi (c.1320–1391) before 1383 in the Conti Chapel, the Santo, Padua (Saint Antony's Revelation to Blessed Luca Belludi of Padua's Liberation from the Tyranny of Ezzelino (Fig. 5). Both show the distinctive outline of the Palazzo della Ragione.

¹⁹ P.D.A. Harvey, ‘Local and Regional Cartography in Medieval Europe’, in *Cartography in Prehistoric, Ancient and Medieval Europe and the Mediterranean*, ed. J. Brian Harley and David Woodward. Vol. 1 (The University of Chicago Press, 1987), 464-501, p.464.

²⁰ Harvey, ‘Local and Regional Cartography in Medieval Europe’, p.466.

²¹ Pierre Lavedan, *Représentations des villes dans l'art du Moyen Age* (Paris: Vanoest, 1954), pp.33-35.



Figure 4. Andriolo de' Santi (c.1320–1375), originally part of the tomb of Ubertino da Carrara c.1350 and placed at the feet of his effigy, Eremitani Padua, formerly chancel of Sant'Agostino, showing the Palazzo della Ragione appearing to be out of alignment with the surrounding street plan. Image from Vio, Ettore, ed. *Il Palazzo Della Ragione Di Padova, La Storia, L'architettura, Il Restauro*. Padova: Signum Padova Editrice, 2008.p.74.



Figure 5. Giusto de' Menabuoi (before 1383.): *View of Padua in the Fourteenth Century*, showing (left) the Palazzo della Ragione which appears to be out of alignment with the surrounding street plan, and (right) detail of the distinctive building of the Palazzo della Ragione. Conti Chapel, Padua, Basilica of Il Santo (Sant'Antonio). © 2012. Photo Scala, Florence.

Without an accurate scale map for 1218, nor any initial commissioning documents regarding layout or building orientation for its original construction, the way is open to apply other approaches to the puzzle of the offset nature of the Palazzo della Ragione.

Another Approach

Since the unique and distinctive orientation of the whole building asks the viewer to explore angles, I was interested in whether the corners of the building were oriented to any particular seasonal phenomena, such as sunrise or sunset positions on the horizon for either solstice or equinox (see Fig.6).

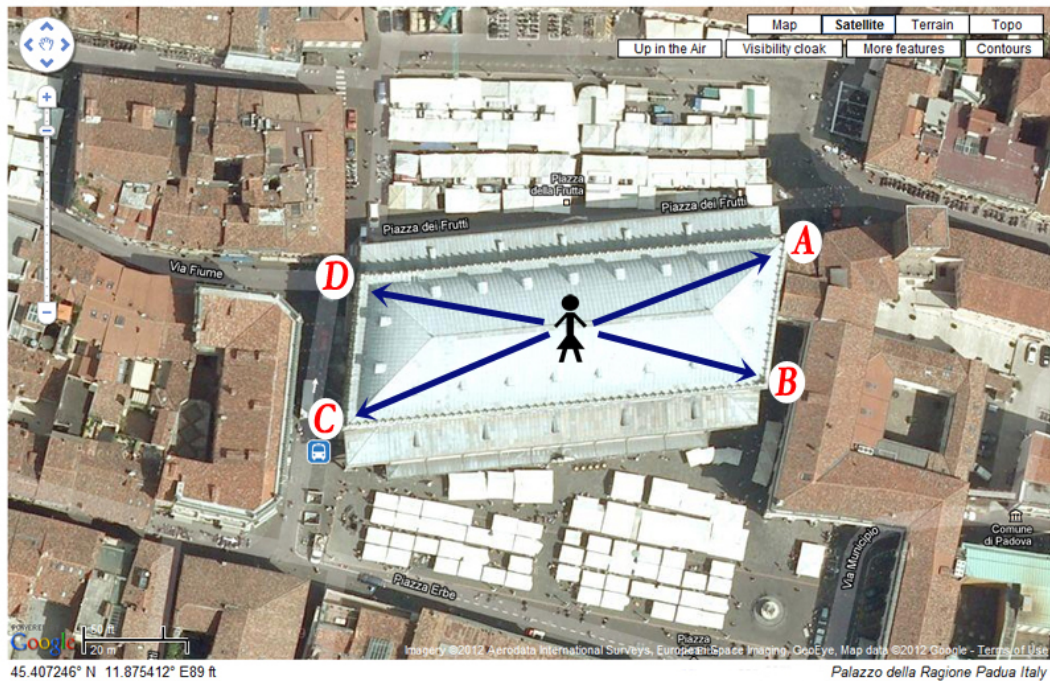


Figure 6. The Palazzo della Ragione from Google Earth showing an observer standing in the centre of the Palazzo della Ragione looking towards each of the four corners.

I took initial measurements of the building on a field trip in Padua in July 2012 and presented my findings at the SEAC conference (The International Conference of the European Society for Astronomy in Culture) in Ljubljana, Slovenia, in September 2012. Incorporating feedback from colleagues, I used a city plan from Google Earth of the Palazzo della Ragione (Fig.3) and overlaid it with a graduated dial based in the centre of the building to find azimuth (Fig.7). The azimuth measurements were then converted to declination.

Azimuth is defined as the horizontal angle of the observer's bearing, measured clockwise from a referent direction, typically true north, measured as a 0° azimuth. Thus moving clockwise on a 360° degree circle, a point due east would have an azimuth of 90° , south

would have an azimuth of 180° , west would have an azimuth of 270° , and so on.²² So if I am standing in the centre of the Salone and facing north at 0° degrees, I can ascertain where, by true compass degrees, a particular corner of the building is pointing (Fig.7). Such a measurement is location specific. So it has precise implications to say that the northeast corner of the Palazzo della Ragione (point A, Fig.6) points towards an azimuth of 68° east of north. To enable this to be related to other locations one needs to take this locally-based measurement and convert it to what is known as declination.

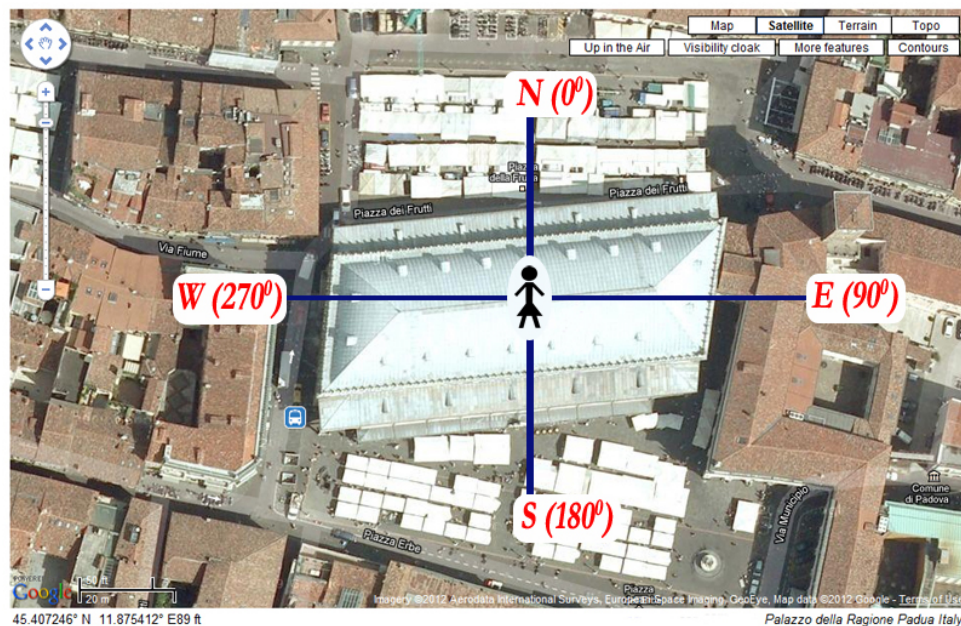


Figure 7. The Palazzo della Ragione from Google Earth showing an observer standing in the centre of the Palazzo della Ragione and azimuth measurements taken from true north at 0° .

Declination is a measurement akin to geographical latitude, measured in degrees north or south of the celestial equator. Since the sun's annual orbit, described by the ecliptic, moves above or below the equator, its declination measurement is directly related to the calendar date in the year. The declination of the sun when it is on the equator (21 March and 21 September) is zero degrees, whereas the declination of the sun when it is at the solstices (23 June and 23 December) means it is at maximum declination at ± 23.5 degrees.

²² Charles Knight, ed. *Arts and sciences: or, Fourth division of "The English encyclopedia"*. Vol. 1. Bradbury: Evans & Co, 1866, p.772.

For an observer standing in the centre of the Palazzo della Ragione the results were as follows. All dating is Old Style (OS) Julian calendar dating, which at that period was seven days behind the Gregorian (NS) calendar (see also Table 19, p.434).

Looking towards point A (Fig.6) (northeast corner):

sunrise will occur on 25 April and 5 August.

Looking towards point B (Fig.6) (southeast corner):

sunrise will occur on 14 February and 15 October.

Looking towards point C (Fig.6) (southwest corner):

sunset will occur on 30 January and 10 October.

Looking towards point D (Fig.6) (northwest corner):

sunset will occur on 5 April and 24 August.

From these findings it is tempting to think that these corners were intended to point to key dates (sunrise or sunset) of the Christian calendar. However, the reality is that the Christian calendar is filled with key dates, and so any credibility of intention is lost in the numerous possibilities of saints' feast days. However, there is more to the orientation of the Palazzo della Ragione than just its corners. Most notably the east and west walls are not parallel. The angle between the south and west walls in the southwest corner at point C on Fig.6 is 76° and the angle between the south and east walls in the southeast corner at point B on Fig.6 is 101° . This remains an unanswered mystery. Of greater interest is the fact that the long axis orientation of the Palazzo della Ragione 'misses' the east-west alignment by 5° (Fig.8).



Figure 8. The long axis of the Palazzo della Ragione overlaid onto Google Earth map showing the azimuth measurements.

A possible explanation - Equinoctial Full Moons and a connection with Easter

In seeking research that would help to make sense of this axis I am indebted to Fabio Silva who directed me in my thinking towards his own examination of ‘equinoctial full moons’, the generalised term he coined to account for the full moon found lying across this axis at the spring equinox.²³ Silva's work was in the field of megalithic dolmens in Central Portugal but his findings with regards to this unique pattern suggested it was worth applying to the Palazzo della Ragione. In terms of what is seen to occur in the sky, at the winter solstice in the northern hemisphere (Fig.9) the sun will be observed to rise at point 1 (towards the southeast) move across the sky at a low altitude, and set at point 2 (towards the southwest). As the sun sets, a full moon will be seen to rise from point 3 (towards the northeast) and travel high in the sky until it sets at point 4 (towards the northwest). At the summer solstice these positions are reversed. The sun rises at point 3, travels high in the sky and sets at point 4, while the full moon will rise at point 1, move across the sky at a low altitude and set at point 2. This means that at some point in the year they have ‘crossed over’ each other and swapped places. This crossing of rise/set positions on the horizon happens around the equinox rising and setting (Fig.9 yellow line).

²³ Fabio Silva and Fernando Pimenta, ‘The Crossover of the Sun and The Moon’, *Journal for the History of Astronomy* 43, no. 151 (2012), 191-208, p.191.

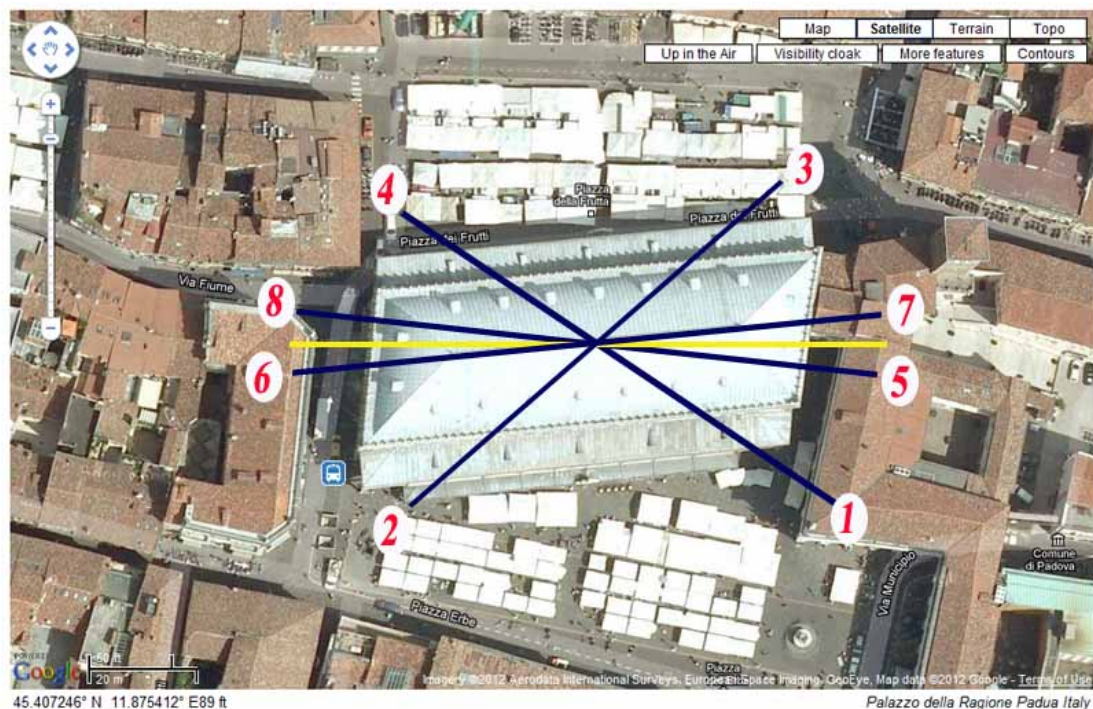


Figure 9. Google Earth map of the Palazzo della Ragione showing the rising and settings of the sun and the moon across the year.

This idea of 'crossover' was proposed by and documented in the work of Cândido Marciano da Silva²⁴ and commented up by Fabio Silva, the latter describing it as follows:

the mere fact that the two luminaries occupy different abodes in different seasons means that they must have swapped places, or crossed-over, at some point. This crossover is empirically observed for the first time at the spring full moon... At such a night the full moon and the sun will rise and set very close to each other (the closest they have been since the autumn) but twelve hours apart. They are seen to have crossed over as well, i.e. the full moon rises more southerly than the sun. The same occurs at the autumn full moon... but the movement is now in the opposite direction... The same effect can be observed whether one looks for it at full moon rise or set.²⁵

This means that at the time of the full moon after the spring equinox, the sun will be rising as the moon sets on the opposite side of the building (see Fig.14 in Appendix for

²⁴ Cândido Marciano da Silva, 'The Spring Full Moon', *Journal for the History of Astronomy* 35, no. 121 (2004), 475-478.

²⁵ Silva and Pimenta, 'The Crossover of the Sun and The Moon', p.192.

more visual information). By azimuth this will occur when the full moon rises at 95° (point 5, Fig.9) and sets at 265° west (point 6, Fig.9), followed by the sun rising at 85° east (point 7, Fig.9) and setting at 275° (point 8, Fig.9). This axis of azimuth 85° (as the sun rises — point 7, Fig.9) and 265° (as the full moon sets — point 6, Fig.9) is the angle of the long axis of the Palazzo della Ragione (Fig.8). To reiterate, this is one of two annual moments when the sun and the moon are equal: in the sky in size; in length of time in the sky; and in the hours of day and night.

Easter

One of the theological questions that troubled the medieval world was how to find Easter, the most significant feast of the Christian liturgical year celebrating the Resurrection of Christ, a time when the Creation of the world was re-established.²⁶ One tradition described how 'the Passion occurred on the vernal equinox, which was the same day on which Christ was conceived, the same day on which the luminaries were created.'²⁷ Since *Genesis* 1:16 stated that on the fourth day the sun and the moon were created equal, the sun to rule the day and the moon to rule the night, this implied they were created when day and night were of equal length, signifying either the spring (21 March) or autumnal (21 September) equinox. However, the understanding that Christ was conceived at this time, nine months before his birth on 25 December, distinguished this as the spring equinox. It also implied that if the moon illuminated the whole night, then this was a full moon.²⁸ Additionally it inferred a time when the sun and moon visually appeared to be of the same shape and size. This suggested, then, that from the medieval Christian perspective, Creation began at the spring equinox,²⁹ and since the sun and the moon were created equal, the moon must then be a full moon. Thus the mystery of the Resurrection of Christ at the same time as he was also conceived — the alpha and omega of creation, the conception and death of Christ, and the time when the sun and moon are equal —

²⁶ Werner Bergmann, 'Easter and the Calendar: The Mathematics of Determining a Formula for the Easter Festival to Medieval Computing', *Journal for General Philosophy of Science* 22, no. 1 (1991), 15-41, p.15. See also Stephen C. McCluskey, 'Gregory of Tours, Monastic Timekeeping, and Early Christian Attitudes to Astronomy', *Isis* 81, no. 1 (1990). See also Evelyn Edson, 'World Maps and Easter Tables: Medieval Maps in Context', *Imago Mundi* 48(1996), 25-42, pp.25-27.

²⁷ Stephen C. McCluskey, *Astronomies and Cultures in Early Medieval Europe* (Cambridge: Cambridge University Press, 1998), p.77.

²⁸ McCluskey, *Astronomies and Cultures in Early Medieval Europe*, p.77.

²⁹ Cyprian, 'De pascha computus', in *Epistolae*, ed. G. Hartel. Vol. 3.3 (Vienna: CSEL: Corpus Scriptorum Ecclesiasticorum Latinorum, 1871), 3.7-10, 14.11.

yielded Easter. Easter was also the day upon which all the moveable feasts depended and thus the importance of calculating the correct date became paramount.

A brief overview of the history of its calculation may be helpful here. *Deuteronomy* 16:1 established Nisan as the first month of the year and the first spring month. *Exodus* 12:1–20 allocated the beginning of Jewish Passover, the week-long commemoration of the emancipation of the Jews from their bondage in Egypt, and the Last Supper of which Jesus partook, to the evening of the full moon after the vernal equinox between the fourteenth and fifteenth days of the Nisan. In 314 the Council of Arle pursued the idea of unifying the celebration of Easter with the instruction *Uno die et uno tempore per omnem orbem* ('On the same day and at the same time throughout the world').³⁰ Gospel accounts make mention of the fact that Christ rose from the grave on the Sunday following the Paschal meal, the Sunday after the fourteenth of Nisan, yet it was not until 324 that the Council of Nicaea finally distinguished Easter as the Sunday after first full moon after the vernal equinox (the paschal full moon). Stephen McCluskey emphasised doctrinal disputes as a major component in the church seeking to differentiate Christian Easter from Jewish Passover.³¹ Although Constantine the Great (c.272–337) wrote a letter to the bishops supporting the edict once it was accepted, as 'it appeared an unworthy thing that in the celebration of this most holy feast we should follow the practice of the Jews',³² as John Heeren argued, Constantine was also aware of the need for uniformity within the church and of avoiding ridicule.³³ The difficulty was how to consistently amalgamate the timing of the cycles of the sun and the moon, as their variations meant that the date of Easter in the calendar changed from one year to the next. The astronomy and mathematics of computus for calculating the date of Easter is a well-ploughed field and not part of this argument.³⁴ Nevertheless the reason for those disputes, McCluskey continued, was not just to find 'a time' but also to establish clearly

³⁰ Clare Vincent and Bruce Chandler, 'Nighttime and Easter Time: The Rotations of the Sun, the Moon, and the Little Bear in Renaissance Time Reckoning', *The Metropolitan Museum of Art Bulletin* 27, no. 8 (1969), 372–384, p.372.

³¹ McCluskey, *Astronomies and Cultures in Early Medieval Europe*, p.80.

³² Eusebius, *Life of Constantine*, ed. Philip Schaff and Henry Wace, trans. Ernest Cushing Richardson, Nicene and Post-Nicene Fathers, Second Series, Vol.1 (Buffalo, NY: Christian Literature Publishing Co., 1890), Vol.III, Ch.XVIII.

³³ John Heeren, 'Another View of Easter and Passover', *American Sociological Review* 49, no. 4 (1984), 581–582, p.581.

³⁴ See for example: Edson, 'World Maps and Easter Tables: Medieval Maps in Context'; James Evans, *The History and Practice of Ancient Astronomy* (Oxford: Oxford University Press, 1998). Bergmann, 'Easter

the time of Creation, the time of salvation in which humankind is renewed, to be once again at that time, *in illo tempore*. The astronomy and mathematics served a sacred purpose; the debates over Easter reflect the importance of that purpose.³⁵

Thus an important marker for Easter is the equinox, a day when the sun will rise due east (90° azimuth) and set due west (270° azimuth) (Fig.7). In returning to the Palazzo della Ragione, its long axis orientation 'misses' this crucial due east-west orientation. It is instead, as noted previously, shifted by 5° and transcribes an axis of azimuth 85° and 265° (Figs.8 and 10).

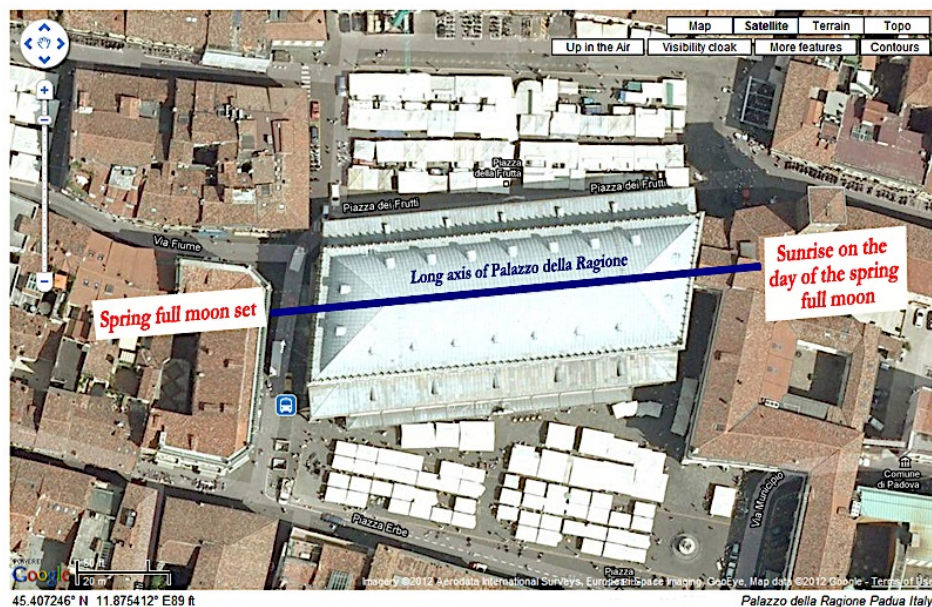


Figure 10. The long axis of the Palazzo della Ragione overlaid onto a Google Earth map pointing to sunrise on the day of the spring full moon and the spring full moon set.

If my speculation has merit, then its application to the alignment of the long axis of the Palazzo della Ragione is profound. I am not arguing that the Palazzo della Ragione was being used as a visual marker for the paschal full moon and thus as a finder for the timing of Easter, as only 90% of the spring full moons were paschal full moons (the first full moon after the equinox).³⁶ Rather I am arguing for a deeper cosmological intent,

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³⁵ McCluskey, *Astronomies and Cultures in Early Medieval Europe*, p.80.

³⁶ Silva and Pimenta, 'The Crossover of the Sun and The Moon', p.197.

anchored into the very fabric of how the Christian world worked —the sacred time when the sun and moon are equal and captured in the feast of Easter, the central event of the Christian drama of salvation and redemption, when the spring equinox was seen theologically as the celebration of light over darkness, the mystery of the Resurrection of Christ at the same time as he was also conceived — the alpha and omega of creation, the conception and death of Christ. To contain this in the building where the judges of the Palazzo della Ragione themselves passed judgements suggests the commune was aligning itself with a theological and cosmological system where celestial order was in unity with earthly justice, and thus comfortable with the discord of the urban plan.

Giotto's Question

If this understanding is correct, then a century later when the commune commissioned astrological imagery to be painted as a fresco scheme along the newly-heightened and hence bare walls of the Salone, another question then becomes apparent. Faced with four blank walls to fresco, where does Giotto start his scheme and, more importantly, why?

Visually when one is standing in the Salone, it is clear that the zodiac imagery of the scheme moves in a clockwise direction (Fig.11).



Figure 11. Google Earth map of the Palazzo della Ragione showing the placement and direction of the zodiac signs painted into the fresco scheme along the top three registers of the first floor Salone.

If Giotto was aware that the building already had a theological and cosmological agenda, then one would suppose that he or his advisors would be sympathetic to this in the fresco scheme, and indeed this is exactly what is found. The summer solstice sunrise when the sun enters the zodiac sign of Cancer, points to the place on the south wall where Giotto began his images for the Cancer 'chapter' (Fig.12).



Figure 12. Clockwise placement of the zodiac signs in the Salone, Padua, Italy. Arrow indicates where light of the sun marked by the external summer solstice sunrise might fall along the south wall if the light had been able to penetrate through the north wall. Not to scale.

At each subsequent sunrise the position of the sun would move along the horizon and therefore point to the images of the scheme moving clockwise around the southwest corner of the Salone through the hot months of Leo and Virgo.

Conversely at the winter solstice when the sun enters the zodiac sign of Capricorn, the sun on the horizon at sunset points to the place on the north wall where Giotto began his images for the Capricorn 'chapter' (Fig.13).

At each subsequent sunset the position of the sun would move along the horizon and therefore point to the images of the scheme moving clockwise around the northeast corner of the Salone through the cold months of Aquarius and Pisces.

This alignment of the internal frescoes scheme to the external solar events implies intent in the actions of Giotto and his advisors.



Figure 13. Clockwise placement of the zodiac signs in the Salone, Padua, Italy. Arrow indicates where light of the sun marked by the external winter solstice sunset might fall along the north wall if the light had been able to penetrate through the south wall. Not to scale.

There is a point where the gathering up of coincidences starts to move an argument beyond pure speculation. I would argue that this is the case here and that the orientation of the long axis of the Palazzo della Ragione aligned to the Easter full moon, linked with the arrangement of the frescoes aligned to the solstice axis, begins to place this argument for the cosmological nature of the Palazzo della Ragione into the realms of possibility rather than one of speculation.

There is a point to be stressed here. This research is not considering precise sunbeaming, such as occurs in the Arena Chapel in Padua, Italy. The Palazzo della Ragione is not funnelling the sun's light through an aperture at a precise angle and at a precise time of year so that an engraving, image or icon can receive it. It is instead looking for some connection between external phenomena and internal imagery, for the internal Salone frescos to be in sympathy with the external building orientation. That this appears to be so, emphasising the seasonal markers of the equinoctial paschal full moon of the vernal equinox, as well as the summer solstice sunrise—winter solstice sunset axis accentuating

the Cancer and Capricorn ingresses offers a reason for why the fresco scheme has been laid out in this way.

Conclusion

It is logical to assume that those who first laid down the foundations of this great civic building were making a conscious statement. I argue this statement was the desire to align the Palazzo della Ragione with the Christian and annual calendar, thus placing the 'Palace of Reason' and earthy judgement in harmony with the moment of creation when all things were in balance, when new life was taking place at the equinox, and when the two lights of the sun and the moon were serving equal time.

Furthermore, the internal fresco emphasising the axis oriented towards the rising sun at the summer solstice and the setting sun at the winter solstice suggests intentional orchestration by Giotto and/or his advisors, and sheds insight on the pattern and layout of the scheme itself. If this is the case, then one can surmise that the civic Palazzo della Ragione was conceived as a cosmic building embracing a religious and civic calendar. It therefore represents the idea of a union of calendar and orientation captured in the internal fresco scheme.

Table 19. Azimuth bearings where 0° equals true north and measurements move in an easterly direction, and converted declination for the Palazzo della Ragione, Padua, Italy: Latitude 45.407246° N Longitude 11.875412° E.			
From the observer's perspective.	Azimuth	Corresponds to Declination...	Calendar
Standing in the middle of Salone looking towards the northeast corner.	68°	15.25	Sunrise
			25 April (OS) = St Mark
			5 August (OS) (15 August = Assumption)
East –west axis of the building.	85°	3.5	Sunrise
			30 March (OS) (25 March = Annunciation)
			15 September (OS) (8 September = BVM Nativity; 21 September = St Matthew)
Standing in the middle of Salone looking towards the southeast corner.	105°	-10.47	Sunrise
			14 February (OS)
			15 October (OS) (18 October = St Luke. Padua claims the translations of the relics.)
Standing in middle of Salone looking towards the southwest corner.	248°	-15.25	Sunset
			30 January (OS)
			10 October (OS)
Standing in the middle of Salone looking towards the northwest corner.	282°	8.4	Sunset
			5 April (OS)
			24 August (OS) (29 August = death of St John the Baptist)

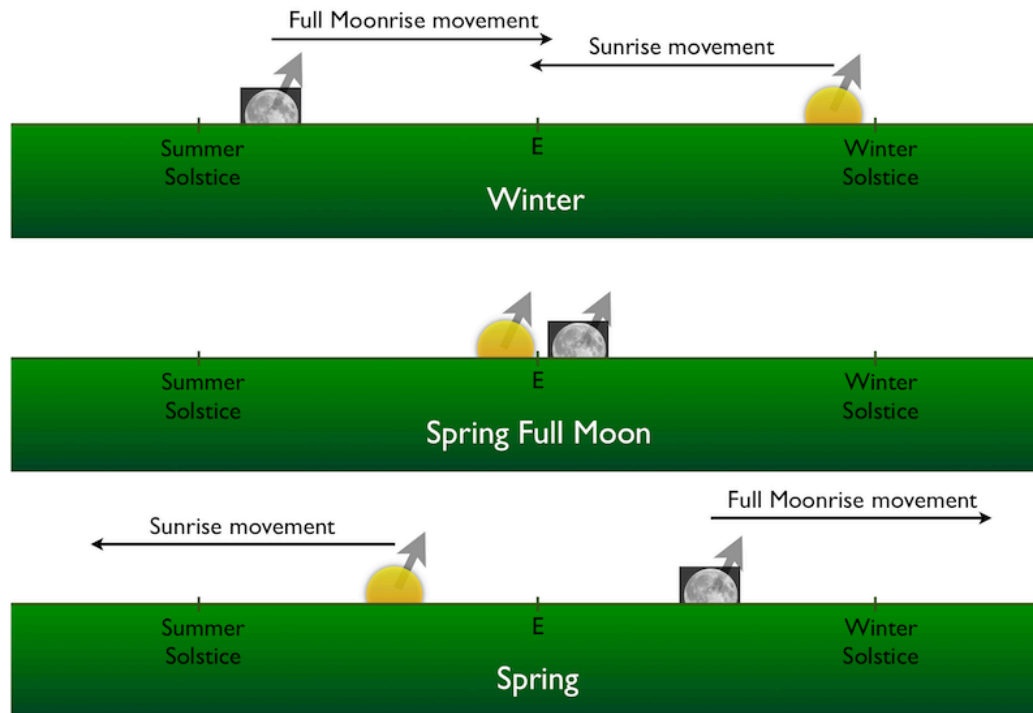


Figure 14. Positions of the sunrise and full moonrise in the eastern horizon months before (top), during (centre) and after (bottom) a spring full moon. The grey arrow and lines indicate the trajectory of the luminaires in the sky immediately after rising. The black arrows illustrate the direction of change in rising points during the indicated seasons.

Diagram: Silva, Fabio, and Fernando Pimenta. 'The Crossover of the Sun and the Moon.' *Journal for the History of Astronomy* 43, no. 151 (2012), p.193. Reprinted with permission.

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