2021

The alignment of passage tombs in Ireland – horizons, skyscape, and domains of power

Frank Prendergast
Technological University Dublin, frank.prendergast@tudublin.ie

Recommended Citation

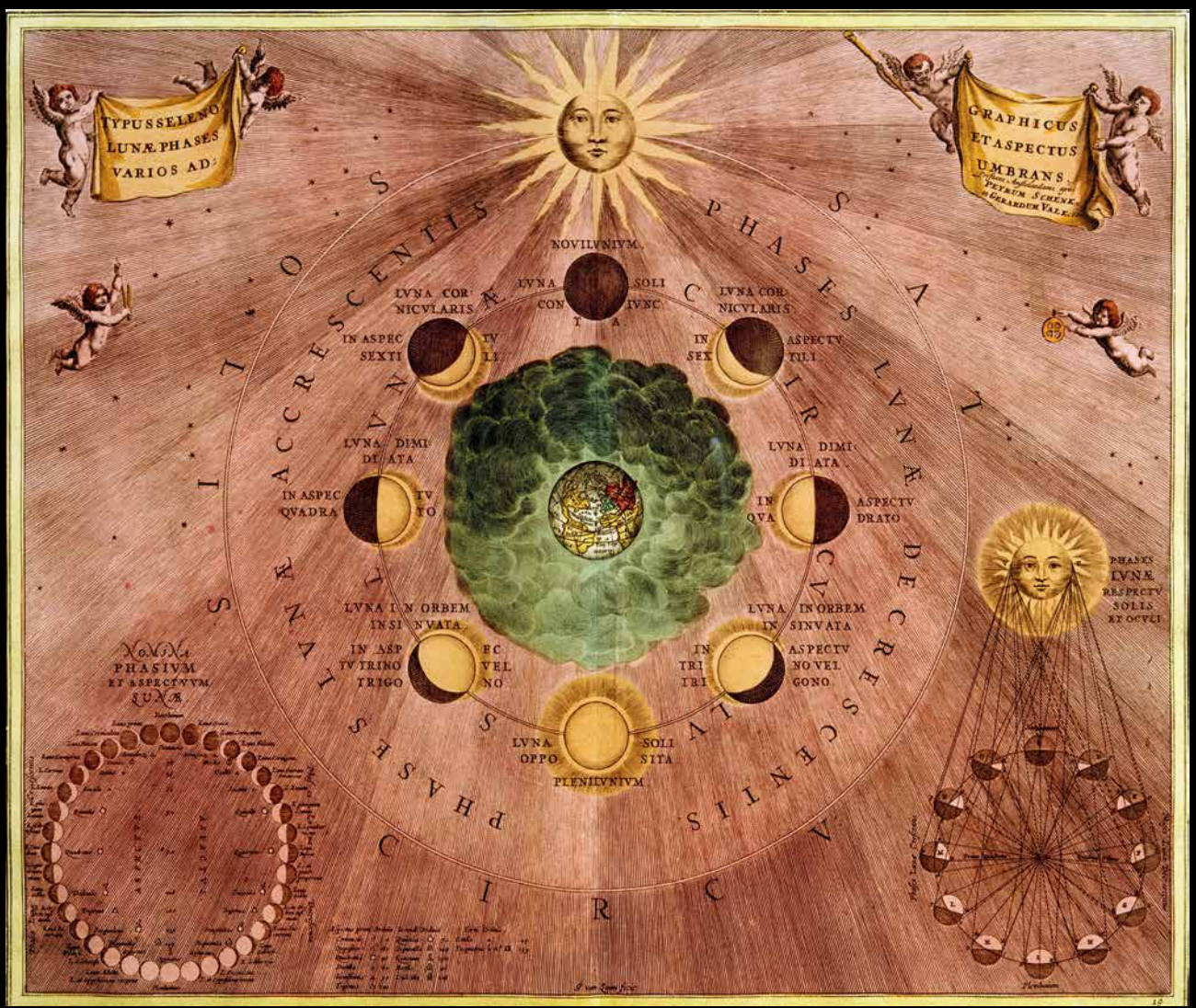
Prendergast, Frank. 2021. "The alignment of passage tombs in Ireland – horizons, skyscape, and domains of power." In Zeit ist Macht. Wer macht Zeit?/Time is power. Who makes time?, edited by H. Meller, A Reichenberger and R. Risch, 107–123. Mitteldeutscher Archäologentag vom 8. bis 10. Oktober 2020 in Halle (Saale)/13th Archaeological Conference of Central Germany October 8–10, 2020 in Halle (Saale): Tagungen des Landesmuseums für Vorgeschichte Halle (Halle [Saale] in Vorbereitung). DOI: 10.21427/qadg-px41

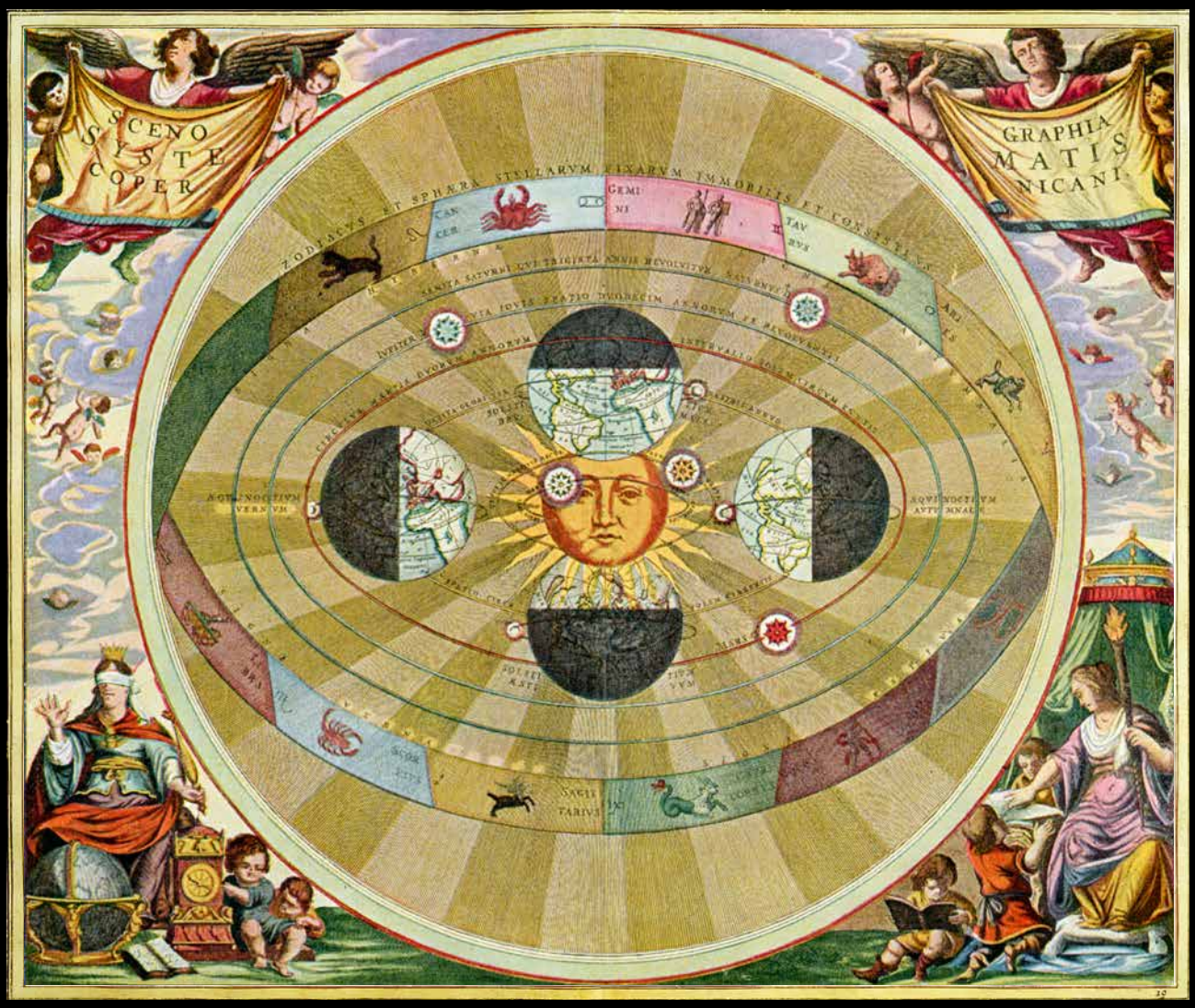
Zeit ist Macht. Wer macht Zeit?
Time is power. Who makes time?

13. Mitteldeutscher Archäologentag 2020

Herausgeber Harald Meller, Alfred Reichenberger, Roberto Risch

24 2021 TAGUNGEN DES LANDESMUSEUMS FÜR VORGESCHICHTE HALLE


TYPUS SELENO
LUNÆ PHASES
VARIOS AD
GRAPHICUS
ET ASPECTUS
UMBRANS
NOVILVNIVM
LVNA CONIVNCTA SOLI
LVNA CORNICVLARIS
IN ASPECTV SEXTILI
LVNA DIMIDIATA
IN ASPECTV QVADRATO
LVNA IN ORBEM INSINVATA
IN ASPECTV TRINO VEL TRIGONO
LVNA OPPOSITA SOLI
PLENILVNIVM
PHASES LVNÆ ACCRESCENTIS
PHASES LVNÆ DECRESCENTIS
CIRCVLVS
PHASES LVNÆ RESPECTV SOLIS ET OCVLI
NOVA PHASIVM ET ASPECTVVM LVNÆ


SCENO
SYSTE
COPER
GRAPHIA
MATIS
NICANI
ZODIACVS ET SPHÆRA STELLARVM FIXARVM IMMOBILIS ET CONSTITVTVS
CAN
CER
GEMI
NI
TAV
RVS
ARI
ETIS
SATVRNI
IOVIS
MARTIS
AQVINOCTIVM
VERNVM
AQVINOCTIVM
AVTVMNALE
SOLSTI
ANTE
SAGIT
TARIVS

Tagungen des
Landesmuseums für Vorgeschichte Halle
Band 24 | 2021

Zeit ist Macht. Wer macht Zeit?
Time is power. Who makes time?

13. Mitteldeutscher Archäologentag
13th Archaeological Conference of Central Germany

Tagungen des
Landesmuseums für Vorgeschichte Halle

Band 24 | 2021

Zeit ist Macht. Wer macht Zeit?
Time is power. Who makes time?

13. Mitteldeutscher Archäologentag
13th Archaeological Conference of Central Germany

Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt
LANDESMUSEUM FÜR VORGESCHICHTE

herausgegeben von
Harald Meller,
Alfred Reichenberger
und Roberto Risch

Halle (Saale)
2021

Die Beiträge dieses Bandes wurden einem Peer-Review-Verfahren unterzogen.
Die Gutachtertätigkeit übernahmen folgende Fachkollegen: Prof. Dr. Oliver Auge, Dr. Jan-Heinrich Bunnefeld, Dr. Wolfgang David, Prof. Dr. Timothy Darvill, Prof. Dr. Pedro Diaz del Rio, Prof. Dr. Hans-Werner Fischer-Elfert, Prof. Dr. Andreas Furtwängler, Mag. Dr. Walter Gauß, PD Dr. Rita Gautschy, Dr. Michael Geschwinde, Dr. Dr. Susanne M. Hoffmann, Prof. Dr. Hermann Hunger, PD Dr. Marc Kalinowski, Dr. Franziska Knoll, Dipl. Museologe Sven Koch, Prof. Dr. Claus Priesner, Dr. Knut Rassmann, Prof. Dr. Jörg Rüpke, Prof. Dr. Maria Shinoto, Prof. Dr. Rudolf Simek, Prof. Dr. Ulrich Sinn, Dr. Vera Tiesler, Mag. Dr. Gerald Unterberger, Dr. Gabriele Weichart, Dr. Sibylle Wolf, Dipl.-Ing. Dr. Georg Zotti

Bibliografische Information der Deutschen Nationalbibliothek
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://portal.dnb.de abrufbar.

ISBN 978-3-948618-22-3

ISSN 1867-440 2

Redaktion Florian Michel, Manuela Schwarz, Anna Swieder • LDA Halle (Saale), David Tucker • Halle (Saale)

Redaktion und Übersetzung der englischen Texte Sandy Hämmerle • Galway (Irland), Isabel Aitken • Peebles (Großbritannien), David Tucker • Halle (Saale)

Organisation und Korrespondenz Claudia Gärtner, Manuela Schwarz
Technische Bearbeitung Anna Engel, Birte Janzen, Brigitte Parsche • LDA Halle (Saale), Thomas Blankenburg • Halle (Saale)

Vor- und Nachsatz Gestaltung Birte Janzen; nach Ausschnitten aus: Andreas Cellarius, Harmonia Macrocosmica, Amsterdam 1708, Blatt 19. Sign. 2" Kart. A 180 Berlin, Staatsbibliothek Preußischer Kulturbesitz © akg-images, Entstehung der Mondphasen/Cellarius; Mond © channarongsds - stock.adobe.com

Schmuckseiten 1–2, Schmutztitel Die Entstehung der Mondphasen. Geozentrisches Weltsystem des Ptolemäus, um 150 n. Chr. Kupferstich, koloriert, aus: Andreas Cellarius, Harmonia Macrocosmica, Amsterdam 1708, Blatt 19. Sign. 2" Kart. A 180 Berlin, Staatsbibliothek Preußischer Kulturbesitz © akg-images, Entstehung der Mondphasen/Cellarius; Heliozentrisches Planetensystem des Kopernikus, 1510. Kupferstich, koloriert. Aus: Andreas Cellarius, Harmonia Macrocosmica, 1660 © akg-images, Weltsystem des Kopernikus/Cellarius

Sektionstrenner Gestaltung Birte Janzen; Bildnachweise siehe jeweilige Rückseite

Umschlag Gestaltung Birte Janzen • LDA Halle (Saale); Motiv: Brigitte Parsche • LDA Halle (Saale); grafische Umsetzung basierend auf einem Foto der astronomischen Uhr am Altstädter Rathaus in Prag (© shutterstock/Curioso.Photography) und der Himmelsscheibe von Nebra (LDA)

Papier alterungsbeständig nach DIN/ISO 9706
Satzschrift FF Celeste Pro, News Gothic

Konzept und Gestaltung Carolyn Steinbeck • Berlin
Layout, Satz und Produktion Anna Engel, Birte Janzen, Brigitte Parsche

Druck und Bindung Löhnert Druck • Markranstädt

Inhalt/*Contents*

2. Zeit und Macht in frühen Staaten und Hochkulturen
Time and power in early states and advanced civilisations

3. Kalender und Zeitmesser in der Antike
Calendar and time-keeping devices in Antiquity

The alignment of passage tombs in Ireland – horizons, skyscape, and domains of power

Frank Prendergast

Zusammenfassung

Die Ausrichtung der Ganggräber in Irland – Horizonte, Himmelsbilder und Herrschaftsbereiche

Neolithische Ganggräber bilden eine von vier Kategorien von Megalithgräbern auf der irischen Insel. In diesem Beitrag wird deren Ausrichtung statistisch und phänomenologisch untersucht. Insgesamt lassen sich 23 Beispiele ermitteln, die zu entscheidenden Zeitpunkten im jährlichen Sonnenzyklus, insbesondere während der Sonnenwenden, auf die auf- oder untergehende Sonne ausgerichtet waren.

Die Ausführungen beruhen auf der aktuellen archäoastronomischen Lehrmeinung, dass angesichts der allgemein eher groben Gräberarchitektur eine bewusste Ausrichtung auf die Sonne relativ unpräzise gewesen sein muss. Jegliche kalendarische Funktion wie beispielsweise die Zeitmessung darf daher als zweitrangig gelten. Astronomisch ausgerichtete Ganggräber werden vielmehr als eine Verkörperung von kulturellen und kosmologischen Vorstellungen angesehen, die mit großer Wahrscheinlichkeit mit dem Ahnenkult verbunden waren und die Verstorbenen mit der als Gottheit verehrten Sonne verbinden sollten. Damit wird auch die achsiale Ausrichtung der Anlagen als symbolische Verbindung mit dem Horizont interpretiert, der hier als eine krafterfüllte und geheimnisvolle Schwelle angesehen wird, die die Grenze zwischen zwei Welten markierte. Die am Horizont auf- und untergehende Sonne schrieb den Tagesrhythmus vor. Auf ihrer Reise über fast 90 Grad von der einen Sonnenwende zur anderen gab sie zudem den Verlauf der Jahreszeiten an. In den Augen der neolithischen Menschen bedeutete dies, dass sie, vor allem wenn sie tangential zum Horizont stand, als wichtigster Himmelskörper und Kraftspender galt, der die Seelen der im Grab bestatteten Elite nährte.

Summary

Neolithic passage tombs are one of four main types on the island of Ireland. This paper considers their orientation within a statistical and phenomenological framework and finds twenty-three examples which face the rising or setting sun at key times in the annual solar cycle, notably the solstices.

The discussion reflects the current archaeoastronomical view that intentional solar alignment was of low precision because of the mostly crude architecture of the tombs. Any calendrical function, such as tracking time, should therefore be viewed as secondary. More significantly, astronomically aligned passage tombs are perceived to embody broader cultural and cosmological beliefs most probably associated with ancestor worship and linking the dead with a deified sun. By extension, axial alignment is interpreted as being symbolically linked with the horizon, considered here as a liminal zone imbued with power and charged with mystery, demarcating the boundary between two worlds. The sun, rising and setting at the horizon, gave diurnal time. Appearing to travel almost ninety degrees from solstice to solstice, it also gave seasonal time. To the Neolithic mind this probably made the sun, especially when it was tangential to the horizon, the supreme cosmic body and source of power in the sky, nourishing the spirits of the elite interred within the tomb.

Introduction

The diurnal passage of the sun and its apparent annual motion along the horizon are widely regarded by scholars of antiquity as having been intimately associated with eternal cycles of life and death. In the Neolithic mind, the rising sun at dawn probably signified rebirth and renewal, the setting sun signifying death. Anthony Stevens similarly argues that, »The setting of the sun, its disappearance at night, and its rising again in the morning links it irrevocably with the archetypal symbolism of death and rebirth« (Stevens 1998, 136). Such ideas legitimise investigating all prehistoric architecture for evidence of culturally meaningful astronomical alignment in order to consider and interpret the ritual symbolism of the phenomenon.

In eastern Ireland alone, at least forty passage tombs lie within an area of eight square kilometres delineated by a pronounced deviation in the River Boyne. This cultural and ritual landscape was inscribed by UNESCO as a World Heritage Site in 1993. Its earthen enclosures, timber post-built enclosures, and megalithic tombs were the undoubted foci of ceremonial and ritual activities during the Neolithic. The ideology of the hierarchically structured society that created it is perceived as being expressed in its burial rites and funerary practices (DOELG 2002, 18).

The cluster of tombs in the Boyne Valley are but a numerically small component of the national and wider European corpus shown in Fig. 1. Where a tomb has an extant chamber and/or passage, the astronomical declination is easily cal-

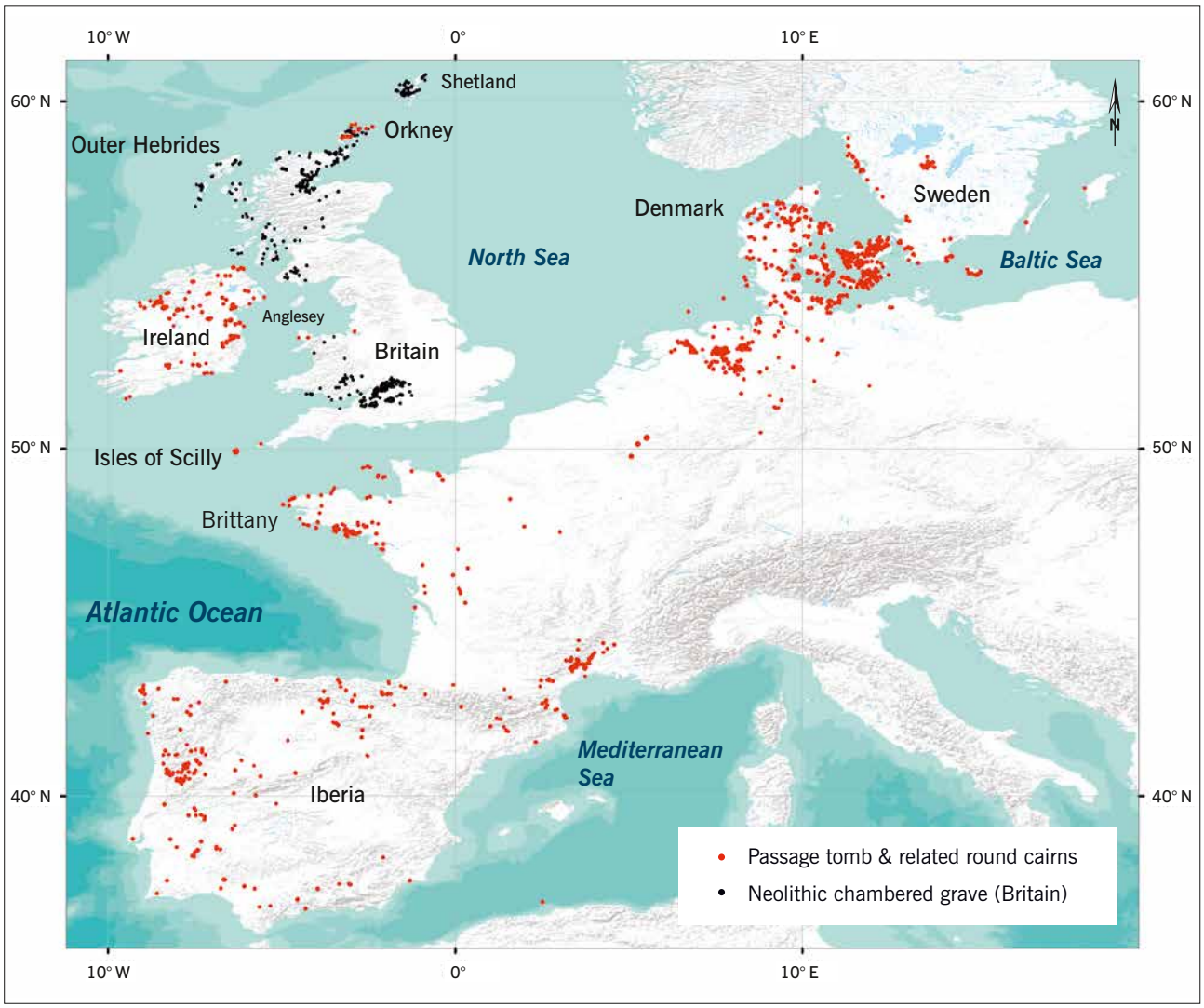


Fig. 1 European distribution of Neolithic chambered tombs: Iberia, France, Ireland, Britain, and northern Europe (Netherlands, Denmark, northern Germany, Sweden). The distributions of Irish Neolithic court and portal tombs are not shown. The map scale is determined by the graticule at 10° intervals.

Abb. 1 *Verbreitungskarte der Kammergräber in Europa: Iberische Halbinsel, Frankreich, Irland, Britannien und Nordeuropa (Niederlande, Dänemark, Norddeutschland, Schweden). Die Fundorte der irischen neolithischen Hof- und Portaldolmen sind nicht kartiert. Der Kartenmaßstab ergibt sich aus dem Gradnetz mit 10° Intervallen.*

culated from measured survey data. Whether the alignment coincides with an indicative celestial target can then be computationally discovered, especially if the target is the rising or setting position of the sun at either solstice. This allows for exploration of the ritual significance of the phenomenon and the symbolism of the way in which funerary traditions and ceremonial practices in the prehistoric past may have been linked with the sun, the supreme celestial body and source of cosmic power.

Before embarking on such an exploration, it is essential to first consider the tangible qualities of the tombs, such as their setting, alongside the intangible findings obtained from archaeoastronomical studies. Such a pairing allows the ceremonial/ritual significance of this type of sacred architecture to be juxtaposed with its obvious functional role in providing places for the interment of the remains of the dead. Furthermore, the cultural significance of any horizon-based astronomical phenomena can be contextualised within a material and phenomenological framework of landscape, skyscape, and otherworld – the entire environmental domain. The discussion here will therefore begin by focusing on the passage tombs in the Boyne Valley and asking the question – why this site? This approach has applicability to any other complex. The topic of astronomical alignment can then be meaningfully contextualised and is discussed later.

The complex of tombs in the Boyne Valley is bounded by two rivers, one being the River Boyne itself on the southern side of the monuments. The River Mattock, a minor tributary, lies 4 km to the north. Both flow eastwards and between them almost completely enclose this cultural landscape, creating a virtual island. Proximity to water could have been a spiritual criterion for the selection of this locality in the Neolithic. In Ireland, the Neolithic spans the period from 4000 to 2400 BC, subdivided into the Early (4000–3600 BC), Middle (3600–3000 BC), and Late Neolithic (3000–2500/2400 BC). Construction of the Newgrange tomb is dated to 3200–3100 cal BC (O'Kelly 1982, 230). Accelerator Mass Spectrometry radiocarbon determinations on cremated and non-burnt human bone have recently been obtained from nine of the twenty tombs at the nearby Knowth complex, 1.2 km

Fig. 2 Map of Irish passage tombs with indications of solar astronomical alignment. The 100 km intervals on the National Grid (ITM Reference System) provide scale. Tomb identity codes in the map are shown in Tab. 1.

Abb. 2 *Kartierung der irischen Ganggräber mit Hinweisen auf eine astronomische Ausrichtung. Der Maßstab ist durch das 100 km-Netz der Landesvermessung (ITM Koordinatensystem) vorgegeben. Die Indentifizierungscodes der Gräber sind in Tab. 1 aufgelistet.*

away. These show that the main phase of funerary activity began there in 3169–3045 cal BC and ended in 3020–2920 cal BC (95 % probability), a span of only 100–220 years (Eogan/Cleary 2017, 378). A few passage tombs have been dated to the Early Neolithic (Bergh/Hensey 2013; Schulting et al. 2017). Chronological dating is necessary for archaeoastronomical analysis of prehistoric architecture, Newgrange included.

The Boyne Valley monumental landscape (or *Brú na Bóinne* meaning the abode of mythological beings) is dominated by an elevated ridge midway between the Boyne and Mattock rivers. The gradient is +20 % if approached from the River Boyne. The most impressive tomb in the complex is undoubtedly Newgrange (the name of the local townland), situated imposingly on the ridge summit. Dominance of the landscape is not peculiar to this tomb. Recent research by the author undertaken at a national scale confirms that the majority of these monuments, which number two hundred and thirty, exhibit deliberate siting on high ground, hilltops and mountain summits (see also Fig. 9). The Irish corpus is shown in Fig. 2.

The mostly elevated locations of passage tombs contrast sharply with those of court and portal tombs, the other principal Neolithic tomb traditions on the island (Shee Twohig 2004). This preference for altitude may demonstrate a cosmological principle – a desire for topographical proximity to the abode of the gods in a perceived tripartite model of the universe having an underworld, a landscape of the living, and an otherworld of ancestral spirits above (Prendergast 2021, 13–42). The anthropologist Edward Tregear was arguably the first to document such a tripartite cultural world view, amongst the Maori people of New Zealand (Tregear 1904).

Next, we consider water – the primary element necessary for life and much more. The River Boyne enters the Irish Sea 20 km to the east. Access to Newgrange from the coast by small boat is readily possible today and is highly likely to have been so in the Neolithic. This supposition is supported by the recent discovery of a floor section from a logboat in the bed of the river close to the tombs, dated to c. 3300–2900 BC (National Monuments Service 2016). Writing about water, Terge Oestigaard describes it as a »medium for reli-

gious and divine interaction«, and refers to its being »forcefully used in ritual practices and religious constructions« and »being fundamental ... to conceptions of the divinities and cosmos in prehistoric religions« (Oestigaard 2011, 38). Ponds and small lakes are also considered to have been used as locations for ritual deposition. Their association with hengiform monuments, including those within the Boyne Valley, is considered »quite distinctive« (Condit/Simpson 1998, 60). When water is channelled in a river it also acquires a powerful significance as a boundary. Rivers were probably worshipped in the prehistoric past »as deities, particularly as masculine river gods who fertilize(d) the lands through which they pass« (Stevens 1998, 111). Rivers were important in funerary rites of passage, too, being used for disposal of the remains of the dead (Parker Pearson et al. 2006).

The mouth of the River Boyne at the coast defines yet another kind of boundary or edge, a liminal junction between two worlds – terrestrial and maritime. The sea would have been an artery connecting distant communities in the Neolithic. The exchange of objects and ideas, including knowledge and traditions relating to horizon-based solar astronomical alignment, is considered likely.

Across that sea, Maeshowe passage tomb, Orkney, is approximately 850 km from Newgrange. Yet cultural interconnectedness is evident from the striking similarities in the style of grooved ware pottery and the elaborate megalithic art on the structural stones in many of the passage tombs in both regions (Sheridan/Cooney 2014). The discovery of a ceremonial macehead at Knowth which originated in Orkney is further evidence of trade (Simpson 1988). Human contact, known to have taken place between the Outer Hebrides and Orkney in c. 3600–3500 BC, is now also evidenced between the Outer Hebrides and the north coast of Ireland from as early as c. 3600 BC (pers. comm. A. Sheridan). The astronomical alignment of some Hebridean and Orkney tombs with the winter solstice sunrise/sunset provides further evidence of such connectedness.

Another example lies directly across the Irish Sea in Anglesey, north-west Wales, 113 km from the mouth of the River Boyne. This is Bryn Celli Ddu, one of only two developed passage tombs in Anglesey, also claiming links with communities in the Boyne Valley (Burrow 2010). The burial chamber and entrance of that tomb are aligned with the summer solstice sunset.

Turning now to society and organisation in the Neolithic, important new genomic research carried out by Lara Cassidy on samples procured from a selection of Irish passage tombs points to an increase in social organisation, hierarchy, and socially sanctioned mating, associated with the emergence of a politico-religious elite and a rapid maritime colonisation linked to the west coast of mainland Europe at that time (Cassidy et al. 2020). The striking similarities between Irish passage tomb architecture and megalithic art with examples found in northern Iberia and Brittany supports this hypothesis (Stout/Stout 2008, 67–83). In this context, the construction and alignment of megalithic tombs »have to be seen as part of a wider set of cultural beliefs and cosmological beliefs« (Cooney 2020, 5).

Scenic analysis of the horizons surrounding the Irish tombs suggests specific site selection based on directed visibility of the northern horizon and sky, bracketing a sector beyond the northerly rising and setting limits of the sun and moon (Prendergast 2021a). The concept of »directed visibility« was first articulated by the archaeologist Stefan Bergh in his research on the passage tombs and landscapes of north-west Ireland (Bergh 1995, 133). This new finding by the author suggests that the spirits of the dead may have been perceived in the Neolithic as journeying to an otherworld to join with the ancestors via the north sky, widely regarded as the prime cardinal direction and portal (e. g. Krupp 1997, 19). In general, these findings imply that tomb siting and the structural orientation of the passage axis were not random acts.

Focusing now on the Newgrange cairn, its dimensions are truly gigantic for its time. The north-east/south-west axis of the mound measures 85 m and the north-west/south-east axis 77 m, creating an oval shape which exhibits a high degree of deliberate bilateral symmetry. The maximum height of the cairn above ground level is more than 11 m and the mass of the structure exceeds 200 000 tonnes. Exotic stones were used to form the entrance passage, burial chamber and facade. Many tonnes of quartz blocks, granite cobbles, and greywacke sandstone were imported via the River Boyne. Local archaeologists Geraldine and Matthew Stout describe how logboats, already discussed, could have been used for their in-shore transportation (Stout/Stout 2008, 11).

Newgrange is considered to be the premier passage tomb on the island of Ireland. It is also intentionally aligned with the rising sun at the winter solstice. Interestingly, Stonehenge is the largest megalithic construct in Britain, with a solstitial alignment embedded in its Bronze Age phase of architecture (e. g. Ruggles 1997a). Similarly, Bryn Celli Ddu in Anglesey, the larger of the two developed passage tombs on that island, is solstitially aligned (Burrow 2010). Maeshowe, the largest developed passage tomb on the mainland of Orkney, is aligned with the setting sun at winter solstice, a fact first noted in 1893 (Towrie 1996–2021). Is it coincidence that alignment with the sun on the horizon at such a seasonally critical turning point is a feature of the largest tomb in each region? Might this reflect the social developments proposed by Cassidy, evidencing a human desire to amplify the monumental distinctiveness and impressiveness of tombs constructed for the interment of an elite? If such a hypothesis is valid, a more detailed consideration of the Newgrange alignment is warranted before searching the Irish archaeological record for similar examples of the phenomenon.

The astronomical alignment of Newgrange

This tomb was first recorded in 1699 by the Welsh antiquarian Edward Lhywd. His rudimentary plan shows the internal structural stones and megalithic art but not its orientation (Lhwyd 1712). Sir Norman Lockyer, an English astronomer, was arguably the first scientist to draw attention to, although not to observe, the possibility of a solstitial alignment with sunrise at the winter solstice. His opinion was derived from an examination of an exact plan (in Borlase 1897) that had been published earlier by George Coffey (Coffey 1892–1896, 4). Lockyer, citing Borlase, wrote (Lockyer 1909, 430):

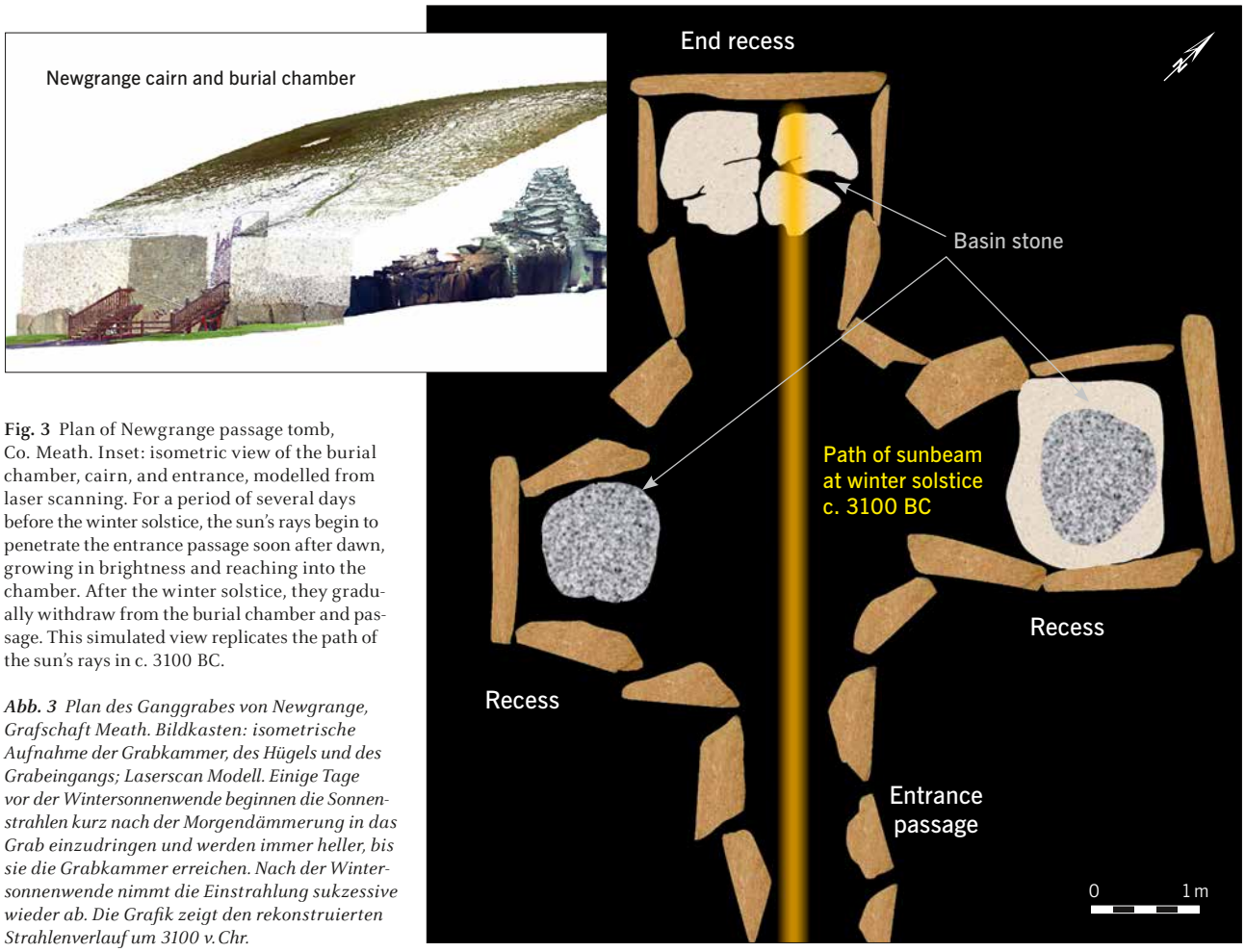


Fig. 3 Plan of Newgrange passage tomb, Co. Meath. Inset: isometric view of the burial chamber, cairn, and entrance, modelled from laser scanning. For a period of several days before the winter solstice, the sun's rays begin to penetrate the entrance passage soon after dawn, growing in brightness and reaching into the chamber. After the winter solstice, they gradually withdraw from the burial chamber and passage. This simulated view replicates the path of the sun's rays in c. 3100 BC.

Abb. 3 *Plan des Ganggrabes von Newgrange, Grafschaft Meath. Bildkasten: isometrische Aufnahme der Grabkammer, des Hügels und des Grabeingangs; Laserscan Modell. Einige Tage vor der Wintersonnenwende beginnen die Sonnenstrahlen kurz nach der Morgendämmerung in das Grab einzudringen und werden immer heller, bis sie die Grabkammer erreichen. Nach der Wintersonnenwende nimmt die Einstrahlung sukzessive wieder ab. Die Grafik zeigt den rekonstruierten Strahlenverlauf um 3100 v. Chr.*

> »Of them all Bryn Celli Ddu is the most interesting, as there is a long *allée courverte* or creep way, which is exceptional in Britain, so far as ›cromlechs‹ go, though many may be still hidden in ›long barrows‹ such as New Grange, which, so far as I can make out, is oriented to the Winter Solstice.«

In the 1960s, more than seventy years after Lockyer's comments, Claire O'Kelly, the wife of Prof. Michael O'Kelly (who was about to commence restoration of the tomb) published an interesting record. She described a belief or tradition in the locality that the rising sun illuminated a small three-spiral motif carved onto the vertical face of stone C10 on the right-hand side of the end recess within the cruciform burial chamber (O'Kelly 1978, 111). Regardless of the veracity of this claim, Prof. O'Kelly confirmed empirically, for the first time in modern times, that the burial chamber faces the rising sun at the winter solstice (O'Kelly 1982, 123–24). Interestingly, the phenomenon of sunlight entering the tomb was live-streamed over the internet at the winter solstice of 2020, enabling a global audience of several million to view the spectacle (Tuffy/Prendergast 2020).

The first scientific analysis of direct sunlight entering the Newgrange burial chamber was carried out by the archaeoastronomer Dr. Jon Patrick on behalf of Prof. O'Kelly. Patrick concluded from his measurements that illumination of the burial chamber occurred when the azimuth and altitude of the sun were between the limits 133° 42'–138° 24' and 0° 55'–1° 40' respectively. The range in astronomical declination corresponding to Patrick's limits is thus -22° 58' to -25° 53'. These angular data delimit the lateral, vertical, and declination limits of the unique slot-opening above the entrance to the tomb (see Fig. 4); this was termed the »roof-box« by O'Kelly. Provided the sun is within the above limits, direct sunlight will reach the end of the burial chamber close to the back-recess of the cruciform chamber. The astronomer Prof. Tom Ray later undertook a similar investigation and brought improved accuracy and certainty to measurements of the phenomenon (Ray 1989). More recent investigations of the roof-box architecture by Ken Williams have further strengthened the case for the intentionality of the alignment (Williams 2019).

Fig. 3 illustrates the cruciform burial chamber at Newgrange. The three recesses each contain a basin stone, considered to be an important element in the funerary ritual at this and other passage tombs (Eogan et al. 2012). In Figure 3 the path of the sun's rays is shown as it would have appeared in the Neolithic, when it would have reached the backstone of the end recess.

A question of probability

The astronomer Douglas Heggie assessed the probability of Newgrange being solstitially aligned. He used Patrick's azi-

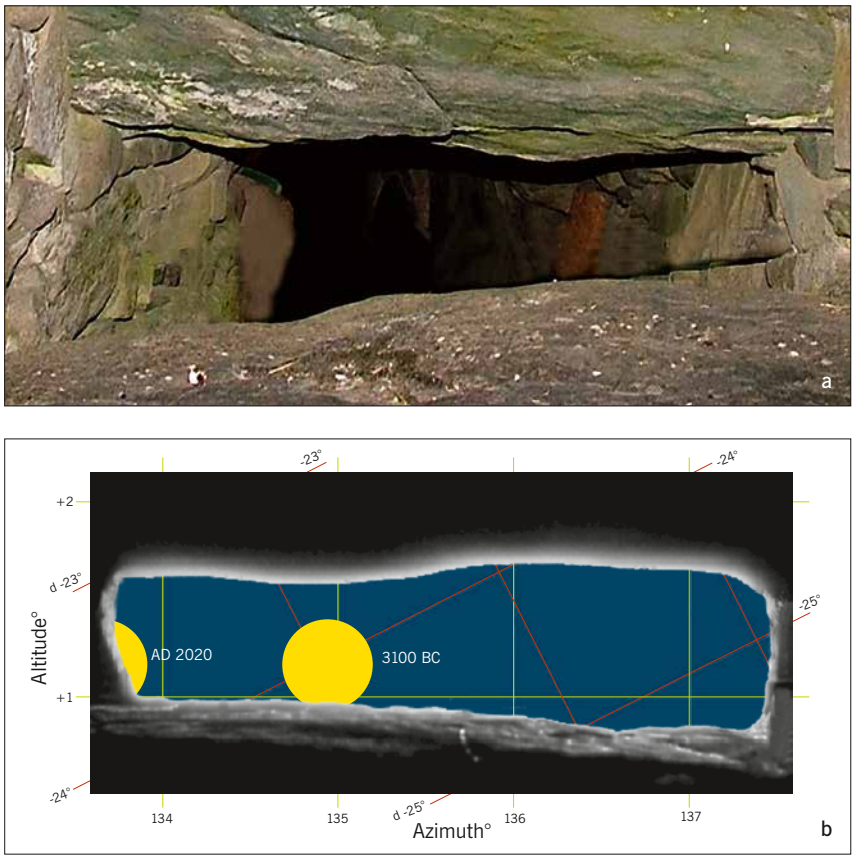


Fig. 4a–b Newgrange roof-box (or slot-opening): **a** view from outside looking in; **b** view from inside looking out, illustrating the change in the sunrise azimuth since the tomb was first aligned with the rising sun at the winter solstice in c. 3100 BC.

Abb. 4a–b *Dachöffnung im Grab von Newgrange:* ***a*** *Blick von außen in das Grab hinein;* ***b*** *Blick vom Grabinneren nach außen; hier wird klar ersichtlich, dass sich der Azimut bei Sonnenaufgang zur Wintersonnenwende seit der Errichtung der Grabkonstruktion um 3100 v. Chr. verschoben hat.*

muthal range of 4° 42' for the roof-box and the azimuths of sunrise at the solstices as targets. Heggie found the probability to be .07 and »not really significant enough to excite much interest« (Heggie 1981, 213). If Ray's revised azimuthal range of 3° 40' is used, the probability becomes .04 which is a slight improvement. It is suggested here, however, that in order to avoid the narrowness of perspective inherent in using astronomical parameters alone, architectural factors, in addition to astronomical ones, must be taken into account, as follows.

- Direct sunlight could not have entered the chamber via the entrance passage, since a massive stone door blocked the entrance. This door, unique amongst passage tombs anywhere, is now re-positioned to allow open access for visitors.
- The specially constructed roof-box above the entrance allows direct sunlight from the rising sun to reach the burial chamber as shown in Figure 3. This opening measures 0.96 m in width and 0.15–0.28 m in height and is also unique in the passage-tomb tradition (Fig. 4). Notably, the roof-box lintel is decorated on its forward edge with a »sophisticated pattern in relief« (O'Kelly 1982, 93), further highlighting its importance.
- O'Kelly discovered that the roof-box had been sealed by two quartz blocks, one of which was *in situ* at the time of excavation. Scratch marks on the surface of stone RS1 point to their repeated removal/insertion (O'Kelly 1982, 96). A description by one of the excavation archaeologists describes the single extant stone as approximately 30–38 cm in length, 20–25 cm in cross section and angular in section (pers. comm. F. Lynch 2015; Lynch 1973). This would suggest that two, perhaps three, such quartz blocks were used to ritually control brightness and darkness inside the tomb. If true, darkness and light, and maybe time itself, were being ritually controlled. The ritual/symbolic use of quartz in Irish prehistory is well documented (Thompson 2005; Driscoll 2015).
- The passage floor rises approximately + 5 % from the entrance to the burial chamber, whereas the angular altitude of the local horizon viewed from the chamber floor through the roof-box is +0° 55'. Critically, the horizon is only visible from the floor of the rear of the chamber when looking outwards through the roof-box. If the as-built distance from the roof-box to the chamber were greater, direct sunlight could not reach the back recess as shown in Figure 3, due to ground-slope. This was first recognised by Patrick and influenced many of O'Kelly's illustrations (O'Kelly 1982, e. g. Fig. 22).
- The height of the roof-box (averaging 28 cm) over the distance from the roof-box to the end recess (approx. 21 m) subtends a vertical angle just larger than the apparent diameter of the solar disc (approx. 0° 30'). This effectively frames the disc of the sun in the roof-box and was probably designed to do so (Fig. 4).
- The ratio of the passage width to its length is about 0.04, increasing the likelihood of intentional astronomical alignment.
- The indicative astronomical declination of the tomb's axis is -24°. This is scientifically consistent with the rising sun at the winter solstice in the Neolithic, as visualised in Figure 4b.

Figure 4 further illustrates the northward azimuthal drift of sunrise over the five thousand years since c. 3100 BC. This amounts to 2.2 solar diameters or about a 1° change in azi-

County	Townland	Fig. 2 code/SMR no.		Site code	δ°	Alignment
Fermanagh	MOYLEHID	a	FER210:050	Belmore	-24.7	WSSR
Dublin	RUSH	b	DU008-013001-	Knocklea	-24.4	WSSR
Meath	NEWGRANGE	c	E019-045----	—	-23.8	WSSR
Kilkenny	KNOCKROE	d	KK034-019001	South-east tomb	-22.9	WSSR
Kilkenny	KNOCKROE	e	KK034-019001	South-west tomb	-22.9	WSSS
Meath	DOWTH	f	ME020-017----	South tomb	-25.2	WSSS
Meath	KNOWTH	g	ME019-030015-	Tomb 15	-24.3	WSSS
Meath	PATRICKSTOWN	h	ME009-071001-	—	-24.3	WSSS
Wicklow	LACKAN	i	WI005-092----	—	-23.8	WSSS
Armagh	SLIEVE GULLION	j	ARM028:007	—	-23.0	WSSS
Meath	CORSTOWN	k	ME015-012004-	Cairn T	-1°.1	EQSR
Sligo	GRANGE NORTH	l	SL014-088----	—	+0.6	EQSR
Leitrim	SHEEMORE	m	LE027-054001-	Tomb A	+0.4	EQSS
Sligo	KNOCKNASHAMMER	n	SL014-211----	P30A	-0.7	EQSS
Londonderry	MONEYDIG	o	LDY019:008	—	+23.3	SSSR
Louth	FAUGHART LOWER	p	LH004-062----	—	+23.7	SSSR
Louth	TOWNLEYHALL	q	LH024-008002-	—	+24.6	SSSR
Waterford	CARRIGLONG	r	WA017-057----	—	+24.9	SSSR
Dublin	BREMORE	s	DU002-001001	Tomb I	+24.5	SSSS
Meath	THOMASTOWN	t	ME015-111----	—	+23.9	SSSS
Sligo	CARROWMORE	u	SL014-209049-	P27	+22.9	SSSS
Sligo	CARROWKEEL	v	SL040-090001-	Cairn H	+23.5	SSSS
Kerry	BALLYCARTY	w	KE038-074----	–	+25°.1	SSSS

Tab. 1 Inventory of astronomically aligned passage tombs in Ireland. SMR No. = national inventory number. WSSR = Winter solstice sunrise; WSSS = Winter solstice sunset; EQSR = Equinox sunrise; EQSS = Equinox sunset; SSSR = Summer solstice sunrise; SSSS = Summer solstice sunset. These represent the primary alignments discussed in the text. In the Neolithic, the astronomical declination (δ) was -24° at the winter solstice, +24° at the summer solstice and approx. ± 0° at the vernal and autumnal equinoxes. At each equinox, the rising/setting sun was, and still is, about midway on the horizon (altitude 0°) between its limiting declination and azimuth values at the solstices (see Fig. 12).

Tab. 1 *Inventar der astronomisch ausgerichteten Ganggräber Irlands. SMR No. = nationale Inventarnummer. WSSR = Sonnenaufgang zur Wintersonnenwende; WSSS = Sonnenuntergang zur Wintersonnenwende; EQSR = Sonnenaufgang zur Tagundnachtgleiche; EQSS = Sonnenuntergang zur Tagundnachtgleiche; SSSR = Sonnenaufgang zur Sommersonnenwende; SSSS = Sonnenuntergang zur Sommersonnenwende. Diese Kürzel beziehen sich auf die wichtigsten im Text erwähnten Ausrichtungen. Im Neolithikum betrug die astronomische Deklination (δ) zur Wintersonnenwende -24°, zur Sommersonnenwende +24° und zur Frühjahrs- bzw. Herbst-Tagundnachtgleiche ungefähr ± 0°. Während der jeweiligen Tagundnachtgleiche stand und steht die auf- bzw. untergehende Sonne ungefähr auf halber Höhe (am Horizont, bei 0°) zwischen den Deklinations- und Azimutwerten während der Sonnenwende (s. Abb. 12).*

muth. The obliquity cycle has a half-period of nineteen thousand years, with the next minimum occurring in 12 000 AD. A gradual extinction of the solar illumination of the Newgrange burial chamber is inevitable well before that date.

The next section examines the Irish archaeological record for examples of other astronomically aligned tombs.

Solar-aligned tombs and statistical approaches to probability

Two hundred and thirty extant passage tombs are distributed across Ireland, mostly in dense or dispersed clusters, with the majority in the northern half of the island (see Fig. 2). One hundred and thirty-six of those still retain a burial chamber and passage, or the ruined remains of such, where the axial azimuth can be measured with confidence. Astronomical declinations can then be calculated for the angular limits of the aperture, field-of-view, or window-of-visibility (see Silva 2014).

Tab. 1 lists twenty-three passage tombs having an astronomical declination indicative of a potentially culturally meaningful solar alignment. These variously face sunrise/sunset at the winter/summer solstice, or sunrise/sunset at the vernal/autumnal equinox (Fig. 5). Whether Neolithic people ever aligned their tombs with the rising/setting sun at the

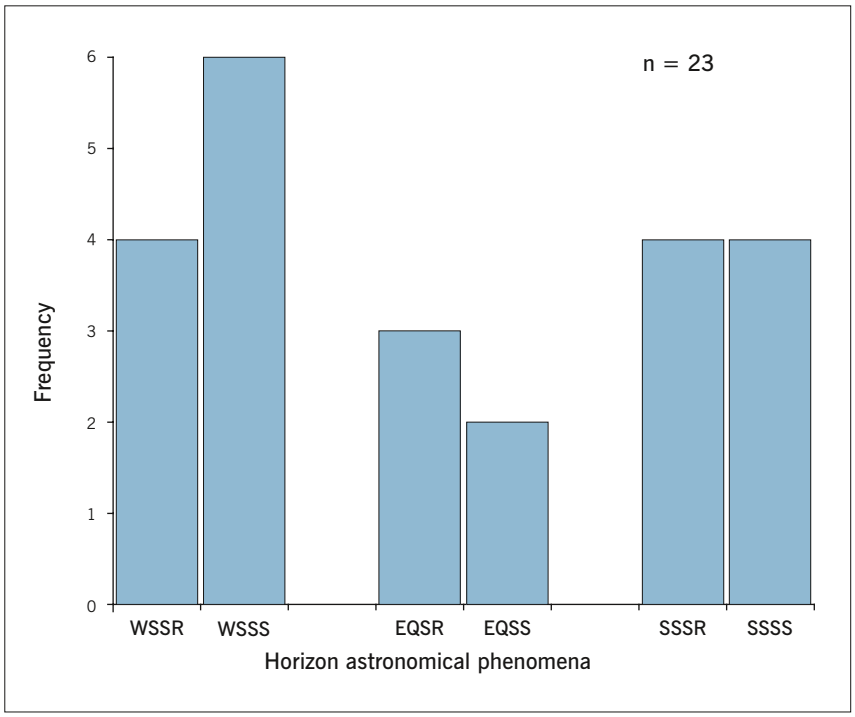


Fig. 5 Frequency of observed sunrise and sunset alignments with solstices and equinoxes in Irish passage tombs.
WSSR = Winter solstice sunrise;
WSSS = Winter solstice sunset;
EQSR = Equinox sunrise;
EQSS = Equinox sunset;
SSSR = Summer solstice sunrise;
SSSS = Summer solstice sunset.

Abb. 5 *Häufigkeit der beobachteten Übereinstimmungen zwischen Sonnenauf- und Sonnenuntergängen und Sonnenwenden bzw. Tagundnachtgleichen in irischen Ganggräbern.*
WSSR = Sonnenaufgang zur Wintersonnenwende;
WSSS = Sonnenuntergang zur Wintersonnenwende;
EQSR = Sonnenaufgang zur Tagundnachtgleiche;
EQSS = Sonnenuntergang zur Tagundnachtgleiche;
SSSR = Sonnenaufgang zur Sommersonnenwende;
SSSS = Sonnenuntergang zur Sommersonnenwende.

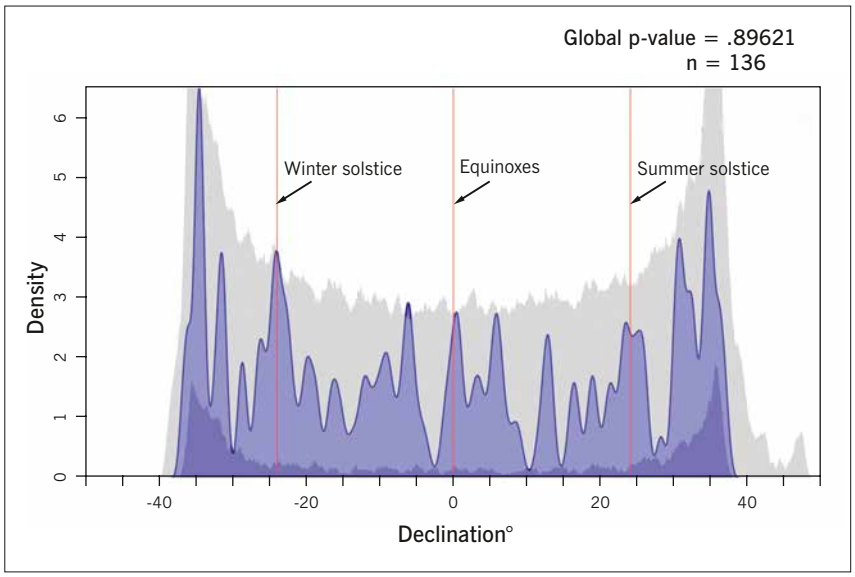


Fig. 6 Significance test applied to Irish passage tomb orientations, running 500 Sum of Probability Densities. The figure shows the confidence envelope of the null hypothesis in grey and the empirical aggregation of orientations in blue. Peaks could represent culturally meaningful declination peaks. Any statistically significant deviations from randomness would appear as blue peaks high enough to appear outside of the grey envelope. The figure is clear in showing that the empirical dataset falls inside the expected range of randomness. The illustration also labels the limits of solar declinations associated with the winter and summer solstices, the primary temporal divisions of the solar cycle likely to have been of ceremonial or ritual importance in the Neolithic. The associated positions of the rising/setting sun would have been easily determined with the naked eye by simple diurnal tracking and referencing the sun on the horizon against memorised distinctive natural features. A tolerance band of ± 1° in declination should be allowed for, being the azimuthal equivalent of ± 2° which equates to ± 4 solar diameters. These lateral limits effectively bracket the sector of sky visible from the chamber and delimited by the width of the entrance in the majority of passage tombs. Note how the declination peak for equinoctial alignments is weakly expressed in the archaeological record in comparison with winter solstice alignments. The complexity of determining sunrise/sunset directions at either equinox is well known (e. g. Prendergast 1991, footnote 7; and see in-text citations).

Abb. 6 *Auf die Ausrichtungen irischer Ganggräber angewendeter Signifikanztest mit 500 Wahrscheinlichkeitsdichtefunktionen. Die Grafik zeigt das Konfidenzband der Nullhypothese in grau und die empirische Orientierungshäufung in blau. Peaks stehen möglicherweise für kulturell bedeutsame Deklinationsspitzen. Jegliche nicht zufällige, statistisch relevante Abweichungen müssten sich als blaue Peaks bemerkbar machen, die höher sind als der graue Bereich. Die Grafik zeigt klar, dass sich die empirischen Daten innerhalb des erwarteten Zufallsbereichs bewegen. Die Abbildung zeigt auch die Grenzen der Sonnendeklination während der Winter- und Sommersonnenwenden auf, welche im Neolithikum als zeitliche Unterteilungen des Sonnenzyklus gedient haben dürften und wohl von hoher zeremonieller bzw. ritueller Bedeutung waren. Die entsprechenden Standorte der auf- bzw. untergehenden Sonne waren mittels täglicher Beobachtung einfach zu ermitteln, indem der Sonnenstand am Horizont im Bezug auf ausgeprägte Landschaftsmerkmale registriert wurde. Dabei muss von einer Deklinationsabweichung von ± 1° bzw. Azimutabweichung von ± 2° oder ± 4 Sonnendurchmessern ausgegangen werden. Diese seitlichen Begrenzungen entsprechen dem tatsächlichen Himmelsbereich, der von der Grabkammer aus sichtbar ist und in den meisten Ganggräbern durch die Breite des Eingangs vorgegeben war. Interessant ist der aus den archäologischen Befunden ermittelte, relativ schwache Peak der Ausrichtungen während der Tagundnachtgleichen im Vergleich zu den Werten zur Wintersonnenwende. Die Problematik der Ermittlung der Sonnenauf- bzw. Sonnenuntergänge an den Tagundnachtgleichen ist allgemein bekannt (z. B. Prendergast 1991, Fußnote 7; siehe auch Zitate im Text).*

Categorical groups (A, B)	Chi-square test	Remarks
(A) Solar aligned; (B) Non-solar aligned	C^2 (1, n = 136) = 59.56, p-value < .001	Reject H_o, $p < 0.05$
(A) Sunrise aligned; (B) Sunset aligned	C^2 (1, n = 23) = 0.04, p-value .83	Do not reject H_o, $p < 0.05$
(A) Solstice aligned; (B) Equinox aligned	C^2 (1, n = 23) = 7.35, p-value .007	Reject H_o, $p < 0.05$
(A) Winter solstice; (B) Summer solstice	C^2 (1, n = 18) = 0.11, p-value .637	Do not reject H_o, $p < 0.05$

Tab. 2 Comparison of observed and expected frequencies of sunrise and sunset alignments using the chi-square test of independence.

***Tab. 2** Vergleich zwischen beobachteten und erwarteten Übereinstimmungen zwischen Sonnenauf- und Sonnenuntergängen mittels eines Chi-Quadrat-Unabhängigkeitstests.*

equinoxes remains a matter of debate (Ruggles 1997a; González-García/Belmonte 2006; Belmonte 2021).

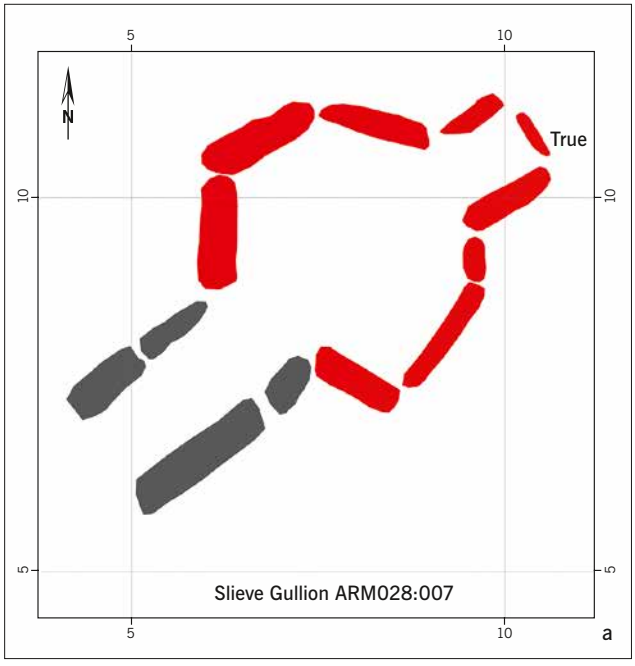
Two statistical approaches are used to test alignment probability. The chi-square (C^2) test simply considers the association between various pairs of categorical variables, e. g. astronomical alignment and no astronomical alignment, in a 2 x 2 contingency table. The null-hypothesis, H_0, asserts the independence of each pair (Tab. 2). A p-value ≤ .05 would suggest that the sample differences are significant (H_1), that the alignment groups being compared cannot be explained by chance, and that intentionality is more likely than not.

Interpreting these results:

- the number of astronomically aligned tombs (solstices, equinoxes) cannot be explained by chance. The same conclusion is reached if the equinoxes are excluded;
- there is no evidence for any greater preference for tombs facing sunrise or sunset at the solstices;
- there is evidence that sunrise/sunset at the solstices was preferred to sunrise/sunsets at the equinoxes;
- tombs face the rising/setting sun at the winter or summer solstice with equal probability;
- astronomically aligned tombs are an island-wide phenomenon, as shown in Figure 2.

The second statistical test uses all one hundred and thirty-six declinations to check whether the available data provide sufficient evidence to discard the possibility of random orientation using a probabilistic framework developed by Fabio Silva (Silva 2020; personal communication, 2021 January 31). According to Silva (who carried out this computation on behalf of the author), a comparison of the observed data and five hundred simulated data sets sharing similar characteristics suggests there is significant evidence against the null-hypothesis (global p-value = .89621, .05). This is shown in Fig. 6 and leads to two conclusions:

- the dataset does not provide enough evidence to reject the hypothesis that the orientations were chosen at random;



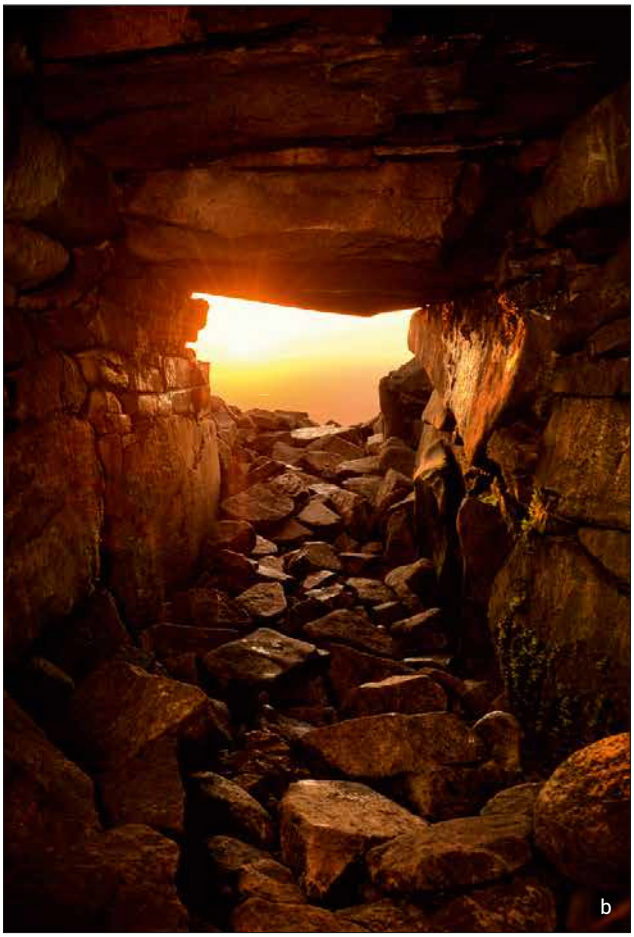
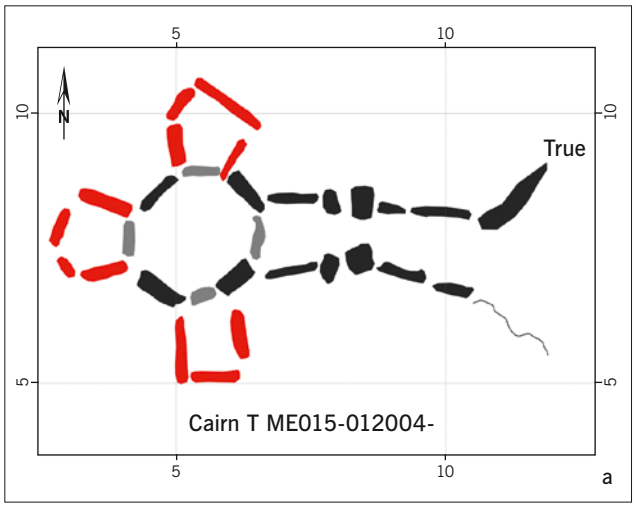


Fig. 7a–b Slieve Gullion, Co. Armagh (south cairn), elevation 575 m. **a** Plan of the octagonal/proto-cruciform burial chamber (grid interval = 5 m). For more archaeological detail, see Collins/Wilson 1963; **b** The setting sun at the winter solstice viewed from the burial chamber, 23 December 2011, 15:47 UTC.

***Abb. 7a–b** Slieve Gullion, Grafschaft Armagh (Südhügel), Höhe 575 m. **a** Plan der achteckigen/frühen kreuzförmigen Grabkammer (Vermessungsnetz im 5 m Abstand); s. Collins/Wilson 1963 für zusätzliche archäologische Informationen; **b** Die untergehende Sonne zur Wintersonnenwende von der Grabkammer aus gesehen. 23. Dezember 2011, 15:47 UTC.*



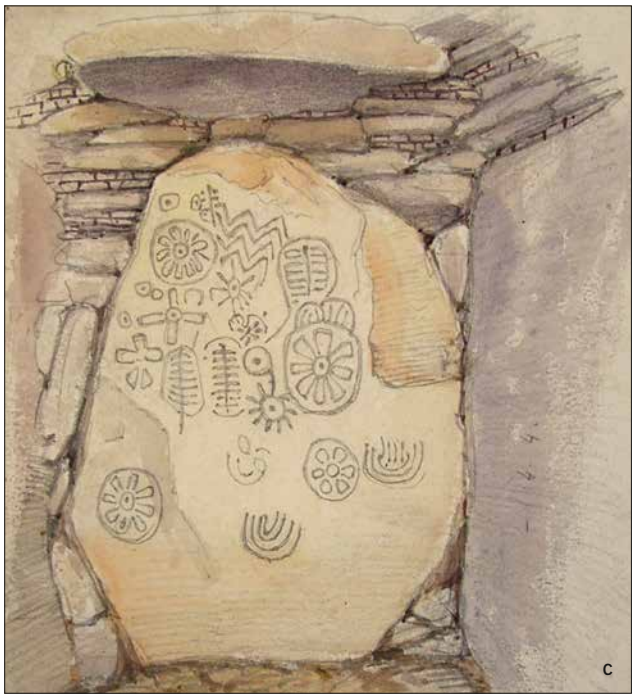


Fig. 8a–c Cairn T, Loughcrew, Co. Meath, elevation 274 m. **a** Plan of the cruciform tomb; **b** The embellished backstone in the end recess illuminated by the rising sun, recorded 22 March 2012, 07:07 UTC. The phenomenon repeats in mid-March and mid-September. **c** The decorated backstone in the end recess.

Abb. 8a–c *Hügel T, Loughcrew, Grafschaft Meath, Höhe 274 m.* ***a*** *Plan des kreuzförmigen Grabes;* ***b*** *Der von der Sonne beleuchtete verzierte Endstein in der hinteren Seitenkammer, aufgenommen am 22. März 2012, um 07:07 UTC. Das Phänomen lässt sich jeweils Mitte März und Mitte September beobachten.* ***c*** *Der verzierte Endstein in der hinteren Seitenkammer.*

- this does not preclude the possibility that a small number (n = 23, Tab. 1), considered to be statistically insignificant, may have been intentionally aligned with solar targets as defined earlier.

Interestingly, these findings strengthen the alternative hypothesis that tombs were aligned with a variety targets, natural, built and celestial, as verified by site fieldwork (Prendergast 2016; Prendergast 2021b).

The next section presents verifiable photographic evidence recorded at selected astronomically aligned passage tombs.

Solar-aligned tombs – case studies

Slieve Gullion, Co. Armagh, is an octagonal or proto-cruciform summit passage tomb featuring a small end chamber constructed by dry-stone walling, a lintelled entrance passage, and a corbelled chamber (Fig. 7). The covering cairn of loose stone is approximately 30 m in diameter and was originally approximately 5 m high. The site commands spectacular views and distant horizons in all directions. The axial alignment (see Tab. 1) is clearly with the winter solstice sunset. This would also have been true in the Neolithic, even though the sun would then have set about two solar diameters to the north. Following this discovery by the author in 2006, an annual hill-climb to witness the phenomenon has become part of a winter solstice festival.

Cairn T, Co. Meath, sits on the summit of the highest of three hills which rise dramatically above the central lowland near Loughcrew. It is considered the focal tomb in this complex of passage tombs and cairns (Fig. 8; see also Fig. 9). Numerous structural stones in the elaborate cruciform corbelled burial chamber are richly embellished with megalithic art. The east-facing passage is aligned with the rising sun at its mid-position between the winter and summer solstice (see also Fig. 12). The solar illumination of the backstone in the end recess is a spectacular phenomenon. It endures only briefly and only for a few days at the equinox because the diurnal change in the sunrise azimuth is at its greatest then (about one solar diameter per day). The phenomenon has been immutable since the Neolithic, as the positions of sunrise/sunset at the equinoxes remain constant regardless of date. Solar illumination of the burial chamber should be considered as symbolic and any precision in a calendrical sense is best treated as coincidental/fortuitous, despite popular ideas to the contrary. The repertoire of motifs engraved on the backstone of the end recess (Fig. 8c) includes several which are construed by some observers as examples of figurative megalithic art representing images of the sun. Such examples are rare in the Irish corpus, but recent archaeological research has advanced and re-invigorated meaningful scholarly debate on this potentially contentious topic (O'Sullivan 1997; Robin 2012; Nash 2013).

The Loughcrew Hills, Co. Meath, is a cultural landscape of international renown. There are eighteen passage tombs and thirteen unclassified cairns dramatically clustered on the slopes and summits of its three hilltops (Fig. 9). Views and intervisibility with more distant Neolithic monuments are striking. Cairn T (see Figs. 8 and 9) is the focal tomb in the

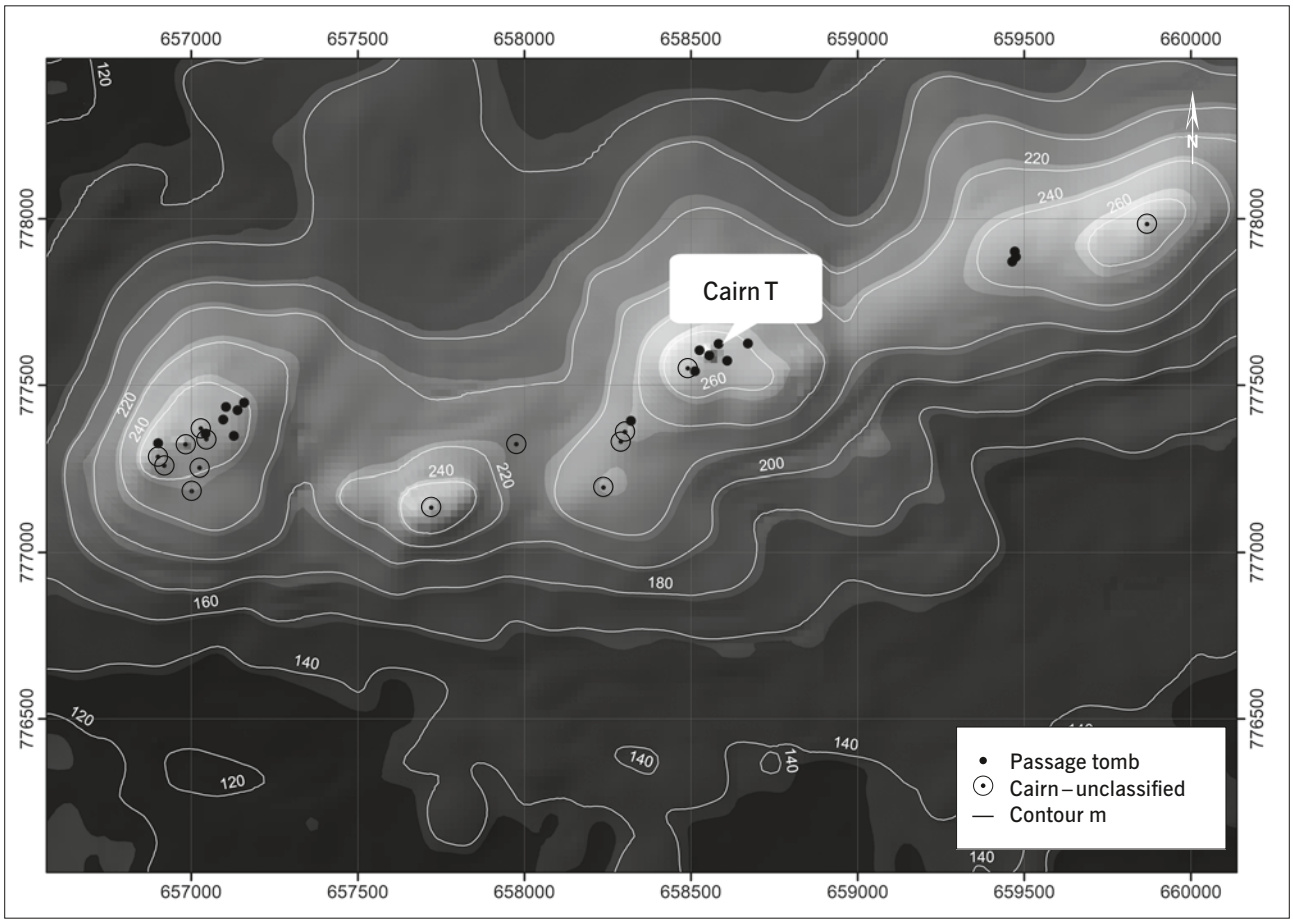


Fig. 9 The hilltop passage tomb complex, Loughcrew, Co. Meath. Tombs and related cairns are shown clustered on three summits: Carnbane West, Carnbane East (with Cairn T) and Patrickstown Hill, which are collectively known as *Sliabh na Calliagh* (or Hill of the Witch). The map scale is determined by the National Grid lines at 500 m intervals.

Abb. 9 *Der auf einem Hügelzug gelegene Ganggräberkomplex von Loughcrew, Grafschaft Meath. Gräber und zugehörige Grabhügel finden sich über drei Erhebungen hinweg verteilt: Carnbane West, Carnbane East (mit Hügel T) und Patrickstown Hill. Der Hügelzug insgesamt trägt den Namen* Sliabh na Calliagh *(Hügel der Hexe). Der Kartenmaßstab ergibt sich aus dem nationalen Vermessungsnetz mit 500 m Abständen.*

Fig. 10a–b Thomastown passage tomb, Co. Meath, elevation 128 m. This site is likely to be the last surviving remnant of a passage tomb complex which was described in the area by Eugene Alfred Conwell (1864, 47–48). Both images capture the sun simultaneously setting over Cairn T and the middle of the three hills (see Fig. 9).

Abb. 10a–b *Ganggrab von Thomastown, Grafschaft Meath, Höhe 128 m. Bei dieser Fundstelle handelt es sich wahrscheinlich um die Überreste eines Ganggrabkomplexes, der erstmals von Eugene Alfred Conwell (1864, 47–48) beschrieben wurde. Beide Abbildungen zeigen die untergehende Sonne gleichzeitig hinter Hügel T und im Zentrum der drei Hügel (siehe Abb. 9).*

complex. This landscape of monuments provides a classic example of the clustering phenomenon evident with Irish passage tombs and demonstrates the well-known preference for siting tombs on locally elevated ground. Collectively, these attributes support suggestions of the emergence of a new cosmology at that time.

Fig. 11a–b Knockroe passage tomb, Co. Kilkenny, elevation 115 m. **a** South-east tomb aligned with the rising sun at the winter solstice, 23 December 2016, 08:46 UTC; **b** South-west tomb aligned with the setting sun at the winter solstice, 16 December 2016, 15:37 UTC. The site was excavated by Prof. Muiris O'Sullivan.

Abb. 11a–b *Ganggrab von Knockroe, Grafschaft Kilkenny, Höhe 115 m.* ***a*** *Das südöstliche Grab mit Ausrichtung auf die aufgehende Sonne zur Wintersonnenwende am 23. Dezember 2016, um 08:46 UTC;* ***b*** *Das südwestliche Grab mit Ausrichtung auf die untergehende Sonne zur Wintersonnenwende am 16. Dezember 2016, um 15:37 UTC. Die Fundstelle wurde von Prof. Muiris O'Sullivan untersucht.*

Thomastown passage tomb, Co. Meath, lies approximately 3 km south-east of Cairn T, somewhat distant from the main cluster to the north-west. An archaeoastronomical survey by the author in 2005 discovered that the passage remnant of this ruined tomb is clearly directed towards the middle and highest of the three hills at Loughcrew and Cairn T. The axial direction and a declination of c. +24° (see Tab. 1) indicate a summer solstice sunset alignment. Moreover, the sun tangentially transits Cairn T momentarily before setting as illustrated in Fig. 10. During the Neolithic, the sun would have set about two solar diameters to the right of where it sets today, due to the change in obliquity. The lack of any modern excavations at Loughcrew has meant an absence of absolute dates for this site. The chronology of Loughcrew is therefore conjectured from the established chronologies for the nearby Boyne Valley megalithic complex (Vejby 2016), 42 km to the east. The Thomastown alignment is currently unique amongst Irish passage tombs in having two targets. It is directed both at the setting sun at the summer solstice and at the summit of the highest neighbouring hill, crowned by focal Cairn T. From a phenomenological perspective, this could represent powerful evidence of a dualism embodying matter and spirit.

Knockroe passage tomb, Co. Kilkenny, was excavated in 1990–1995 by Prof. Muiris O'Sullivan. Notable features include a raised earthen platform scraped into the hillside and a complete kerb delimiting the now denuded round cairn, composed of three layers – a boulder layer, a reddish soil layer and a top layer of small stones. Unusually, Knockroe has two tombs, replicating the gigantic Knowth tomb in the Boyne Valley, 150 km to the north-east. The south-west tomb at Knockroe is the larger of the pair, with an undifferentiated passage and burial chamber. Many of the structural orthostats are decorated with megalithic art (O'Sullivan 2004). The south-east and south-west tombs are aligned with the winter solstice sunrise and sunset respectively (Fig. 11).

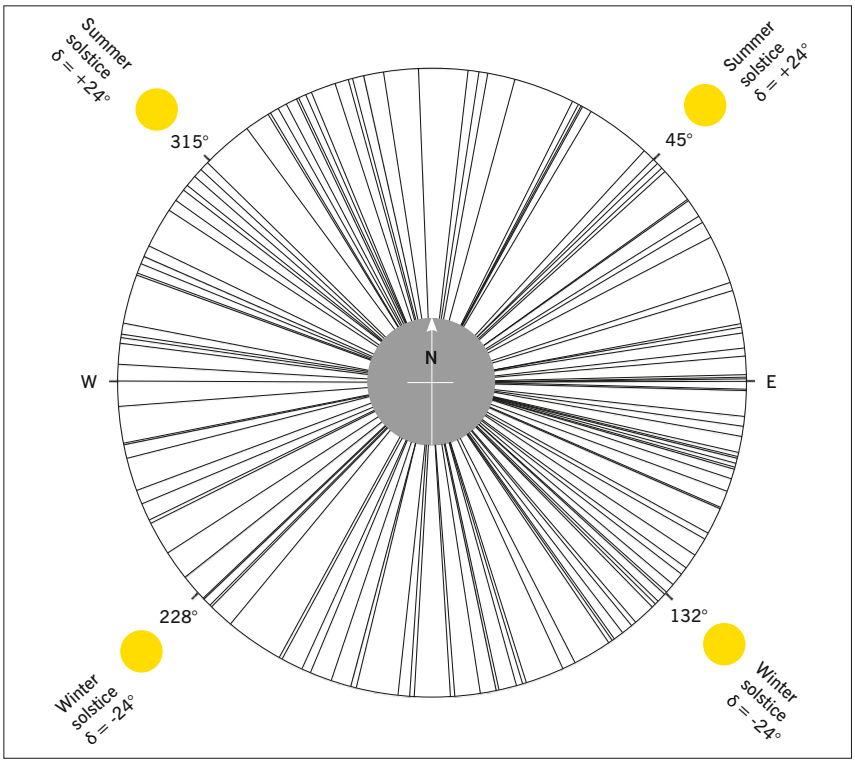


Fig. 12 A representation of the axial azimuths of 136 Irish passage tombs with the limiting azimuths and declinations of the sun at the winter and summer solstices (valid for Ireland c. 3100 BC and 0° altitude horizon). Each radius in this figure represents the azimuth of a passage/chamber measured outwards from its centre. The distribution around all points of the compass is obvious, contributing to the broad range of declinations shown in Fig. 6. A nearest-neighbour test of the azimuths (Neave/Selkirk 1983) and a test statistic T = 0.49 for the null-hypothesis that the orientations are random suggest there is little evidence of clustering in the data. This is borne out by the declination curvigram shown in Fig. 6.

***Fig. 12** Grafik der achsialen Azimute von 136 irischen Ganggräbern mit ihren Azimutgrenzen und Sonnendeklinationen zur Winter- und Sommersonnenwende (gültig für Irland um 3100 v. Chr. und mit 0° Horizont). Jeder Radius in dieser Abbildung stellt das Azimut eines Ganges/einer Kammer, vom Zentrum her gemessen, dar. Die Azimute sind offensichtlich über alle Windrichtungen verteilt, was auch die große Bandbreite an Deklinationen in Abb. 6 erklärt. Ein Nächste-Nachbarn Test der Azimute (Neave/Selkirk 1983) mit einer Teststatistik von T = 0,49 für die Nullhypothese der Zufälligkeit der Ausrichtungen erbringt geringe Hinweise auf Datenhäufung. Dies ist auch aus dem Kurvendiagramm der Deklinationen in Abb. 6 ersichtlich.*

This is unique amongst Irish passage tombs and possibly elsewhere.

The four sites described above are examples selected from the catalogue of twenty-three astronomically aligned sites shown in Table 1. The final section of this paper will discuss their context, significance, and symbolism.

Domains of power

In the formative era of archaeoastronomy in the 1960s and 1970s, studies of prehistoric alignment were largely characterised as being devoid of any meaningful cultural contexts. On this point, the archaeologist Sean Ó Ríordáin wrote, »There is no doubt that orientation was considered important by Prehistoric Man, not only in stone circles but in some megalithic tombs; its importance has been obscured by the extravagant claims made by its protagonists, who have sometimes argued about orientation as if primitive man used precision instruments« (Ó Ríordáin 1979, 162). Decades later, Gabriel Cooney (in Doyle et al. 2020, 5) acknowledged the relatively recent shift from an emphasis on »seeking a level of astronomical precision that perhaps said more about the researchers and our modern western views of time and accuracy than it did about the understanding and beliefs of prehistoric people living in very different cultural contexts«, adding that »alignments have to be seen as part of a wider set of cultural and cosmological beliefs«. In the same publication by Doyle, seven western European authorities stressed the necessity for cross-disciplinary approaches in order to advance and marry up theory and method in relation to the interpretation of alignment in prehistoric architecture.

In pursuit of this aim, the data in this paper were analysed using the chi-square test of independence, in order to identify any evidence of association between pairs of categorical variables such as astronomically and non-astronomically aligned tombs (Fig. 5 and Tab. 2). Recapping, the same data was independently tested by Fabio Silva for statistical significance using his advanced methodology (Silva 2020, and see Fig. 6). The declinations used were determined by the author from field-based measurements of azimuth and horizon altitude at all tombs with an extant passage. If taken as a unit, i. e. n = 136, the resulting curvigram by Silva does not provide enough evidence (global p-value = .89621) to reject the hypothesis that orientations were decided upon by the tomb builders in a random manner. However, Silva does state (pers. comm. 02.02.2021) that this test does not preclude the possibility that the small number listed in Table 1, though statistically insignificant, were intentionally aligned with the rising/setting sun, in particular, the solar declination limits associated with the winter and summer solstice (Fig. 12).

A rigorous interpretation of Figure 6 could imply that the intentional alignment of any/all Irish passage tombs should be consigned to the bin of statistical insignificance. Taking Newgrange as a prime example, numerous other factors already discussed forcefully explain how its alignment was realised thanks to planning and engineering skills developed over an extended period by a local community during the Middle Neolithic. Solstitial alignment was probably a vital part of that design rationale and the same was possibly true of other similarly aligned tombs. But if declination alone is treated as an indicative determinant then this is arguably too narrow a perspective for trying to penetrate the deeper cultural significance of the alignment phenomenon. The discussion must therefore blend the archaeoastronomical indications with the broadest range of additional types of evidence procured from archaeology, ethnography (if relevant) and field observations showing a linkage between the structural

Fig. 13 Cairn H, Carrowkeel, Co. Sligo, elevation 305 m. The 20 m diameter cairn has a smaller 14 m diameter kerb concealed underneath the cairn slip. The passage and chamber are undifferentiated. The astronomical declination of the axis is approx. +24° indicating an alignment with the summer solstice sunset. The tomb is one of many in the Carrowkeel-Keshcorran mountain complex.

Abb. 13 *Hügel H, Carrowkeel, Grafschaft Sligo, Höhe 305 m. Der Gesamtdurchmesser des Hügels beträgt 20 m, wobei er unter der Hügelschüttung eine kleinere Hügeleinfassung mit einem Durchmesser von 14 m aufweist. Der Gang und die Kammer sind nicht klar voneinander zu unterscheiden. Die astronomische Deklination der Achse ist ungefähr + 24°, was auf eine Ausrichtung auf die untergehende Sonne zur Sommersonnenwende hindeutet. Dieser Befund ist einer von vielen vergleichbaren Befunden in der Hügellandschaft von Carrowkeel-Keshcorran.*

axis of the tomb and any distinctive outlying built or topographical feature. To this set of criteria must be added theoretical concepts and ideas surrounding sacred architecture which are rooted in anthropology and architectural design theory.

The bigger picture – design perspectives and meaning

The creation of any prehistoric burial tomb embodied *inter alia* prior experience and tradition, the selection of place, the idea of built form, axial alignment, and perceptions of the cosmos and horizon. All would have been deemed critical to fulfilling the funerary, mortuary, and ritual needs of the community and the dead. Looking at the elevated ground obviously favoured by the passage tomb builders, in Ireland at least, the Norwegian architect Christian Norberg-Schultz advocates »place« as the root of all design inspiration (Norberg-Schulz 1980, 50–55). The anthropologist Thomas J. Hannon observes (Hannon 1983, 264) that there was a strong cultural tendency to place cemeteries on hilltops so as to be generally remote from farmland and, critically, to be closer to the perceived abode of deities and the spirits of the dead. Robert Hertz (1907; 1960, 96) was, perhaps, the earliest anthropologist to articulate ideas of a tiered cosmos and the imbuing of the horizon with cultural significance. Hertz drew on ethnographic studies of New Zealand's Maori society by Tregear (1904, 91; 403) who discovered that the skyline was an elemental part of the Maori belief system and world view. Harvesting of the Kumara crop in that culture was restricted to periods when the bright star Vega was above the horizon. Moreover, to the Maori, the visible likeness of a deified ancestor sometimes announced itself as a rising star identified as »Venus flashing along the horizon«.

On the perception of the horizon, Pierre von Meiss (1989, 155) wrote, »The horizon is a limit even if this limit is in reality intangible, because the more we advance, the more the horizon is replaced by new horizons«. The architect Ian Ritchie observes, »The skyline can be seen as the traditional domain of power, whether secular or religious«, adding that, »Skylines can themselves be monuments and monumental«, and that we may read »economic, political and religious

geography, and history« from the skyline (Ritchie 2004, 10–11). Ritchie stresses that visibility of the skyline matters in design terms, and that a skyline should be considered as the domain of power, a monument and monumental.

It is legitimate and logical to connect the burial chamber of any tomb, in a virtual sense, with the horizon – the horizon being an interface between the underworld and the cosmos, a liminal zone where most celestial bodies rise and set. Architecturally, any structural axis is recognised as the most ancient and fundamental design element. In a prehistoric burial tomb, the axis emerges through the entrance (Fig. 13). It can be symbolically charged with formality, ceremony, and ritual, associated with acts of procession and deposition in the context of the funerary tradition. If an axis is perceived as a virtual cord joining the spirits of the interred dead with the supreme celestial orb of the rising or setting sun, especially at the solstice, the symbolical power of both in surely amplified.

Conclusions

There can be little doubt that the ancient skyscape and the cyclical movements of the brightest of its starry elements were noticed and incorporated into the daily lives and rituals of people in the prehistoric past. The only uncertainty is the degree to which this was an elemental part of the belief system in those times. Control, order, and power would have been crucial to the proper functioning of those societies. So too was balance, symmetry, and boundary. This is obviously expressed in the circular architecture of the cairns and especially in the spatial differentiation exhibited in the cruciform design of some burial chambers. It is also apparent that a ring of kerbstones delimited the covering cairn, defining a boundary. Several dualities are implied by this boundary – interior darkness and external light (see Fig. 13), the world of the dead and that of the living, social exclusion and inclusion, defined by hierarchy and rank in both the dead and the living.

The societal shift from the hunter gatherer lifestyle of the Mesolithic to a comparatively sedentary one in the Neolithic was profound. Settlement, farming, and animal husbandry saw the growth of wealth-based societies, accompanied by social stratification led by elites. This undoubtedly propelled the development of elaborate rituals and ceremonies, implied by recent discoveries of long-lost ceremonial structures in the Boyne Valley (Condit/Keegan 2019). The solar alignment of a limited number of tombs as described here must surely have been an integral part of those ancient rituals.

Acknowledgements

The author is very grateful to Ken Williams (<https://blog.shadowsandstone.com/>) for permission to use his photographic images, recorded at several of the sites. I am also indebted to Ken for his time spent on site to capture the phenomena and create the verifiable images of scientific and heritage value.

I also thank Dr. Fabio Silva, Department of Archaeology and Anthropology, Bournemouth University, for his willingness to undertake the invaluable statistical processing of my data used in this paper.

Bibliography

Belmonte 2021
J. A. Belmonte, »What Equinox?« In: E. Boutsikas/S. C. McCluskey/J. Steele (eds.), Advancing Cultural Astronomy: Studies in Honour of Clive Ruggles (New York 2021) 11–33.

Bergh 1995
S. Bergh, Landscape of the Monuments: A Study of the Passage Tombs in the CúIl Irra Region, Co. Sligo, Ireland. Ark. Unders. Skr. 6 (Stockholm 1995).

Bergh/Hensey 2013
S. Bergh/R. Hensey, Unpicking the Chronology of Carrowmore. Oxford Journal Arch. 32,4, 2013, 343–366.

Borlase 1897
W. C. Borlase, The Dolmens of Ireland (London 1897).

Burrow 2010
S. Burrow, Bryn Celli Ddu Passage Tomb, Anglesey: Alignment, Construction, Date, and Ritual. Proc. Prehist. Soc. 76, 2010, 249–270.

Cassidy et al. 2020
L. M. Cassidy/R. Ó Maoldúin/T. Kador/A. Lynch/C. Jones/P. C. Woodman/E. Murphy/G. Ramsey/M. Dowd/A. Noonan/C. Campbell/E. R. Jones/V. Mattiangeli/D. G. Bradley, A dynastic elite in monumental Neolithic society. Nature 582, 2020, 384–388.

Coffey 1892–1896
G. Coffey, On the Tumuli and Inscribed Stones at New Grange, Dowth, and Knowth. Transact. Royal Irish Acad. 30, 1892–1896, 1–96.

Collins/Wilson 1963
A. E. P. Collins/B. C. S. Wilson, The Slieve Gullion Cairns. Ulster Journal Arch. 26, 1963, 19–40.

Condit/Keegan 2019
T. Condit/M. Keegan, The Archaeology of the Brú na Bóinne World Heritage Site: Interim Report, December 2018. Aerial investigation and mapping of the Newgrange landscape, Brú na Bóinne, Co. Meath, <https://www.archaeology.ie/sites/default/files/files/bru-na-boinne-interim-report.pdf> (27.05.2021).

Condit/Simpson 1998
T. Condit/D. Simpson, Irish Hengiform Enclosures and Related Monuments: A Review. In: A. M. Gibson/D. D. A. Simpson (eds.), Prehistoric Ritual and Religion: essays in honour of Aubrey Burl (Stroud 1998) 45–61.

Conwell 1864
E. A. Conwell, On Ancient Remains, hitherto undescribed, in the County of Meath. Proc. Royal Irish Acad. (1836–1869) 9, 1864, 42–50.

Cooney 2020
G. Cooney, Introduction. In: P. Doyle (ed.), Pathways to the Cosmos – the alignment of megalithic tombs in Ireland, Britain and Atlantic Europe (Sandyford, Dublin 2020) 5–6.

DOELG 2002
Department of the Environment and Local Government (ed.), Brú na Bóinne World Heritage Site Management Plan (Dublin 2002).

Doyle et al. 2020
P. Doyle/G. Cooney/R. Bradley/J. Downes/M. O'Sullivan/F. Prendergast/C. Ruggles/C. Scarre/F. Silva/C. Tuffy/K. Williams, Pathways To The Cosmos – the alignment of megalithic tombs in Ireland, Britain and Atlantic Europe (Sandyford, Dublin 2020).

Driscoll 2015
K. Driscoll, The role of quartz in Neolithic lithic traditions: a case study from the Thornhill Early Neolithic palisaded enclosure, Co. Londonderry, Northern Ireland. Proc. Royal Irish Acad. Section C: Arch., Celtic Stud., Hist., Linguistics, Lit. 116, 2016, 3–29.

Eogan/Cleary 2017
G. Eogan/K. Cleary, Excavations at Knowth 6: The Passage Tomb Archaeology of the Great Mound at Knowth (Dublin 2017).

Eogan et al. 2012
G. Eogan/E. Shee Twohig/K. Williams, Containing the dead in Irish Passage Tombs. In: W. Britnell/R. Silvester (eds.), Reflections-on the Past: Essays in honour of Frances Lynch (Welshpool 2012) 33–47.

Esri Inc. 1999–2015
Esri Inc., ArcGIS 10.4.1 for Desktop (Licensed to Technical Univ., Dublin), <http://www.esri.com/en-us/arcgis/products/arcgis-online/overview> (09.06.2021).

González-García/Belmonte 2006
A. C. González-García/J. A. Belmonte, Which Equinox? Archaeoastronomy 20, 2006, 97–107.

Hannon 1983
T. J. Hannon, The Cemetery: A Field of Artifacts. In: A. E. Ward, Forgotten Places and Things: Archaeological Perspectives on American History Center. Anthr. Stud. 6 (Albuquerque NM 1983) 263–265.

Heggie 1981
D. C. Heggie, Megalithic Science: Ancient Mathematics and Astronomy in North-west Europe (London 1981).

Hertz 1960 (1907)
R. Hertz, Death and the Right Hand. Translated by R. Needham/C. Needham (Aberdeen 1960).

Hijmans 2016
R. Hijmans, DIVA-GIS, <http://www.diva-gis.org/gdata> (31.05.2021).

Krupp 1997
E. C. Krupp, Skywatchers, Shamans and Kings: Astronomy and the Archaeology of Power (New York, Chichester 1997).

Lhwyd 1712
E. Lhwyd, Some further observations relating to antiquities and natural history of Ireland. Phil. Transact. 27, 1712, 524–526.

Lockyer 1909
J. N. Lockyer, Stonehenge and other British Stone Monuments Astronomically Considered[2] (London 1909).

Lynch 1973
F. Lynch, The use of the passage in certain passage graves as a means of communication rather than access. In: G. Daniel/P. Kjærum (eds.), Megalithic graves and ritual: papers presented at the III Atlantic colloquium, Moesgård 1969 (Copenhagen 1973) 147–161.

Meiss 1989
P. von Meiss, Elements of Architecture: From Form to Place (London 1989).

Nash 2013
G. Nash, Aspect, Architecture, and Art: The Passage Grave Tradition of Northwest Britain. Time and Mind 6,2, 2013, 199–210.

National Monuments Service 2016
National Monuments Service, Discovery of a 5000 year old logboat in the River Boyne at Oldbridge, Co. Meath (Dublin 2016), <https://www.archaeology.ie/underwater-archaeology/wreck-of-the-month> (31.05.2021).

Neave/Selkirk 1983
H. R. Neave/K. E. Selkirk, Nearest-Neighbour Analysis of the Distribution of Points on a Circle. Univ. Nottingham Statistics Group Research Report (Nottingham 1983).

Norberg-Schulz 1980
C. Norberg-Schulz, Genius Loci: Towards a Phenomenology of Architecture (London 1980).

O'Kelly 1978
C. O'Kelly, Illustrated Guide to Newgrange and the other Boyne Monuments[3] (Blackrock, Cork 1978).

O'Kelly 1982
M. J. O'Kelly, Newgrange: Archaeology, art and legend (London 1982).

O' Sullivan 1997
M. O' Sullivan, On the Meaning of Megalithic Art. Brigantium 10, 1997, 23–35.

O'Sullivan 2004
M. O'Sullivan, Little and Large: Comparing Knockroe with Knowth. In: H. Roche/E. Grogan/J. Bradley/J. Coles/B. Raftery (eds.), From Megaliths to Metal: Essays in Honour of George Eogan (Oxford 2004) 44–50.

Ó Ríordáin 1979
S. P. Ó Ríordáin, Antiquities of the Irish Countryside[5] (London, New York 1979).

Oestigaard 2011
T. Oestigaard, Water. In: T. Insoll (ed.), The Oxford Handbook of the Archaeology of Ritual and Religion (Oxford 2011) 38–50.

Parker Pearson et al. 2006
M. Parker Pearson/J. Pollard/C. Richards/J. Thomas/C. Tilley/K. Welham/U. Albarella, Materializing Stonehenge: The Stonehenge Riverside Project and New Discoveries. Journal Material Culture 11,1–2, 2006, 227–261.

Prendergast 1991
F. T. Prendergast,Shadow Casting Phenomena at Newgrange. Survey Ireland 9, 1991, 9–18, <https://arrow.tudublin.ie/arastart/10/> (31.05.2021).

Prendergast 2016
F. Prendergast, Interpreting megalithic tomb orientation and siting within broader cultural contexts. Journal of Physics: Conference Series 685, 2016, 1–18, doi: 10.1088/1742-6596/685/1/012004, <https://arrow.tudublin.ie/beschconart/14/> (31.05.2021).

Prendergast 2021
F. Prendergast, The Archaeology of Height: Cultural Meaning in the Relativity of Irish Megalithic Tomb Siting. In: D. Gunzburg/B. Brady (eds.), Space, Place and Religious Landscapes: Living Mountains (London, New York, Oxford, New Delhi, Sydney 2021) 13–42.

Prendergast 2021a
F. Prendergast, The North Sky and the Otherworld: journeys of the dead in the Neolithic considered. In: E. Boutsikas/S. C. McCluskey/J. Steele (eds.), Advancing Cultural Astronomy: Studies in Honour of Clive Ruggles (New York 2021) 141–165.

Ray 1989
T. P. Ray, The winter solstice phenomenon at Newgrange, Ireland: accident or design? Nature 337,6205, 1989, 343–345.

Ritchie 2004
I. Ritchie,The Spire (Herne Bay 2004).

Robin 2012
G. Robin, The figurative part of an abstract Neolithic iconography: hypotheses and directions of research in Irish and British passage tomb art. In: A. Cochrane/A. Meirion Jones (eds.), Visualising the Neolithic: Abstraction, Figuration, Performance, Representation. Neolithic Stud. Group Seminar Papers 13 (Oxford 2012) 140–160.

Ruggles 1997
C. L. N. Ruggles, Astronomy and Stonehenge. Proc. Brit. Acad. 92, 1997, 203–229.

Ruggles 1997a
C. L. N. Ruggles, Whose Equinox? Archaeoastronomy 22 = Journal Hist. Astronomy suppl. 28, 1997, S45–S50.

Schulting et al. 2017
R. J. Schulting/M. McClatchie/A. Sheridan/R. McLaughlin/P. Barratt/N. Whitehouse, Radiocarbon Dating of a Multi-phase Passage Tomb on Baltinglass Hill, Co. Wicklow, Ireland. Proc. Prehist. Soc. 83, 2017, 305–323.

Shee Twohig 1981
E. Shee Twohig, The Megalithic Art of Western Europe (Oxford 1981).

Shee Twohig 2004
E. Shee Twohig, Irish Megalithic Tombs[2] (Princes Risborough 2004).

Sheridan/Cooney 2014
A. Sheridan/G. Cooney, The Boyne to Brodgar Initiative: understanding and preserving, presenting and raising awareness of Neolithic monuments and the people who built and used them in Ireland, Scotland and the Isle of Man. Journal Irish Arch. 23, 2014, 1–11.

Silva 2014
F. Silva, A Tomb with a View: New Methods for Bridging the Gap between Land and Sky in Megalithic Archaeology. Advances Arch. Practice 2,1, 2014, 24–37.

Silva 2020
F. Silva,A probabilistic framework and significance test for the analysis of structural orientations in skyscape archaeology. Journal Arch. Scien. 118, 2020, 1–13.

Simpson 1988
D. D. A. Simpson, The Stone Maceheads of Ireland. Journal Royal Soc. Ant. Ireland 118, 1988, 27–52.

Stevens 1998
A. Stevens, Ariadne's Clue: A guide to the symbols of humankind (Princeton NJ 1998).

Stout/Stout 2008
G. Stout/M. Stout, Newgrange (Cork 2008).

Thompson 2005
T. Thompson, Clocha Geala/Clocha Uaisle: White Quartz in Irish Tradition. Béaloideas 73, 2005, 111–133.

Towrie 1996–2021
S. Towrie, Maeshowe and the Winter Solstice, <http://www.orkneyjar.com/history/maeshowe/solstice.htm> (31.05.2021).

Tregear 1904
E. Tregear, The Maori Race (Wangunui 1904), <https://archive.org/details/cu31924026469753> (31.05.2021).

Tuffy/Prendergast 2020
C. Tuffy/F. Prendergast, National Monuments Service/Office of Public Works, Winter Solstice at Newgrange World Heritage Site, 20.–22.12.2020, <https://www.youtube.com/watch?v=8anbIH-XfPU>, <https://www.youtube.com/watch?v=FDPWSysfWWw>, <https://www.youtube.com/watch?v=esAkRoqjKx4> (31.05.2021).

Vejby 2016
M. Vejby, New radiocarbon dates from Loughcrew Cairn H carved bone slips. Past 25, 2016, 12–14.

Williams 2019
K. Williams, Rekindling the Solstice Light. Arch. Ireland 33,4, 2019, 19–24, doi: 10.2307/26844509.

Source of figures

1 Sources: Esri, USGS, NOAA; map compiled by the author in ArcMap (Esri Inc. 1999–2015) from open-source digital mapping data (Hijmans 2016) and tomb locations measured by the author or published in numerous national and research inventories; tomb locations in Portugal are in courtesy of F. Silva

2 author

3 plan, after O'Kelly 1982, Fig. 21 with additions by the author; inset: courtesy of The Discovery Programme, Centre for Archaeology and Innovation Ireland

4–6 author

7a–b a after Collins/Wilson 1963, Fig. 5; b K. Williams

8a–c a after Shee Twohig 1981, Fig. 232; b K. Williams; c watercolour drawing by G. V. Du Noyer, MS 3D3 1861–1867, Royal Irish Academy Library © RIA

9 illustration compiled by author in ArcMap (Esri Inc. 1999–2015)

10–11 K. Williams

12–13 author

Table 1–2 author

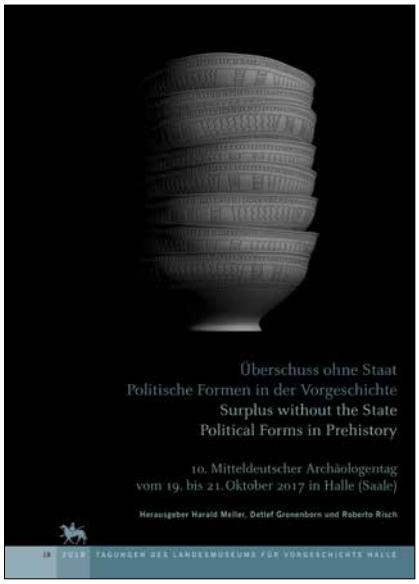
Address

Dr. Frank Prendergast
Emeritus Research Fellow
Technological University Dublin
College of Engineering and Built Environment
Bolton Street Campus
Dublin D01 K822
Ireland
frank.prendergast@tudublin.ie

Bislang erschienene Bände in der Reihe »Tagungen des Landesmuseums für Vorgeschichte Halle«

Die Reihe der Tagungsbände des Landesmuseums wurde 2008 ins Leben gerufen. Anlass dazu war die Konferenz »Luthers Lebenswelten«, die im Jahr 2007 in Halle (Saale) ausgerichtet wurde. Bereits der zweite Tagungsband widmete sich mit dem Thema »Schlachtfeldarchäologie« dem Mitteldeutschen Archäologentag, der seit 2008 jährlich vom Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt veranstaltet und zeitnah publiziert wird. Dem großen Anteil internationaler Autorinnen und Autoren entsprechend, erscheinen viele Beiträge dieser Reihe in englischer Sprache mit deutscher Zusammenfassung.

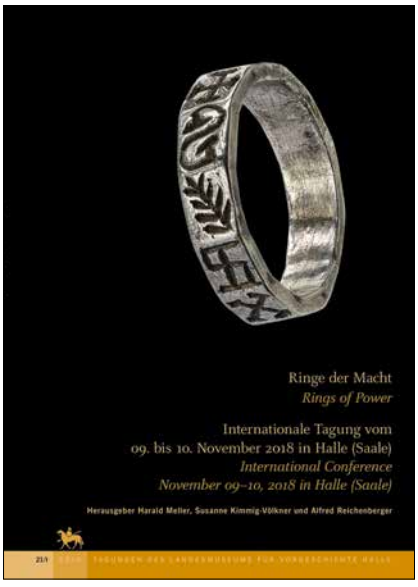
Mit dem zuletzt erschienenen Tagungsband konnten die Vorträge der Internationalen Konferenz »Von den Hunnen zu den Türken – Reiterkrieger in Europa und Zentralasien« in zahlreichen Artikeln renommierter Forscher verschiedenster Fachdisziplinen vorgelegt werden.



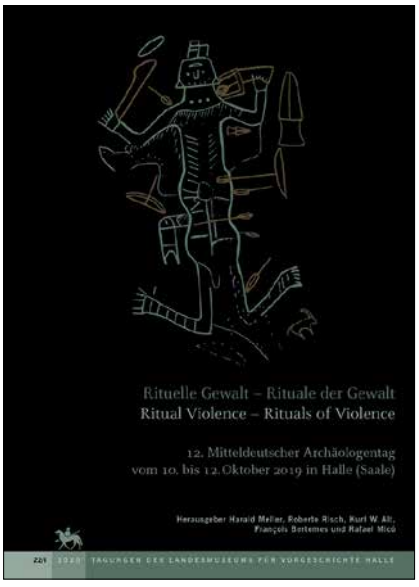
Band 18

Band 19

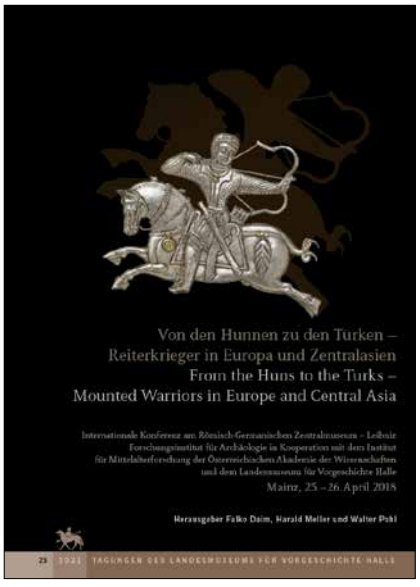
Band 20/I



Band 21/I



Band 22/I



Band 23

Band 1/2008 Harald Meller/Stefan Rhein/Hans-Georg Stephan (Hrsg.),
Luthers Lebenswelten.
Tagung vom 25. bis 27. September 2007 in Halle (Saale).
ISBN 978-3-939414-22-3, ~~€ 39,00~~ € 9,00

Band 2/2009 Harald Meller (Hrsg.),
Schlachtfeldarchäologie. *Battlefield Archaeology.*
1. Mitteldeutscher Archäologentag vom 09. bis 11. Oktober 2008 in Halle (Saale).
ISBN 978-3-939414-41-4, € 35,00

Band 3/2010 Harald Meller/Kurt W. Alt (Hrsg.),
Anthropologie, Isotopie und DNA – biografische Annäherung an namenlose vorgeschichtliche Skelette?
2. Mitteldeutscher Archäologentag vom 08. bis 10. Oktober 2009 in Halle (Saale).
ISBN 978-3-939414-53-7, ~~€ 29,00~~ € 9,00

Band 4/2010 Harald Meller/Regine Maraszek (Hrsg.),
Masken der Vorzeit in Europa I.
Internationale Tagung vom 20. bis 22. November 2009 in Halle (Saale).
ISBN 978-3-939414-54-4, ~~€ 32,00~~ € 9,00

Band 5/2011 Harald Meller/François Bertemes (Hrsg.),
Der Griff nach den Sternen. Wie Europas Eliten zu Macht und Reichtum kamen.
Internationales Symposium in Halle (Saale) 16.–21. Februar 2005.
ISBN 978-3-939414-28-5, ~~€ 128,00~~ € 29,00

Band 6/2011 Hans-Rudolf Bork/Harald Meller/Renate Gerlach (Hrsg.),
Umweltarchäologie – Naturkatastrophen und Umweltwandel im archäologischen Befund.
3. Mitteldeutscher Archäologentag vom 07. bis 09. Oktober 2010 in Halle (Saale).
ISBN 978-3-939414-64-3, ~~€ 32,00~~ € 16,00

Band 7/2012 Harald Meller/Regine Maraszek (Hrsg.),
Masken der Vorzeit in Europa II.
Internationale Tagung vom 19. bis 21. November 2010 in Halle (Saale).
ISBN 978-3-939414-90-2, ~~€ 32,00~~ € 16,00

Band 8/2012 François Bertemes/Harald Meller (Hrsg.),
Neolithische Kreisgabenanlagen in Europa. *Neolithic Circular Enclosures in Europe.*
Internationale Arbeitstagung 7. bis 9. Mai 2004 in Goseck (Sachsen-Anhalt).
ISBN 978-3-939414-33-9, ~~€ 59,00~~ € 29,00

Band 9/2013 Harald Meller/François Bertemes/Hans-Rudolf Bork/Roberto Risch (Hrsg.),
1600 – Kultureller Umbruch im Schatten des Thera-Ausbruchs? *1600 – Cultural change in the shadow of the Thera-Eruption?*
4. Mitteldeutscher Archäologentag vom 14. bis 16. Oktober 2011 in Halle (Saale).
ISBN 978-3-944507-00-2, ~~€ 69,00~~ € 34,00

Band 10/2013 Harald Meller/Christian-Heinrich Wunderlich/Franziska Knoll (Hrsg.),
Rot – die Archäologie bekennt Farbe.
5. Mitteldeutscher Archäologentag vom 04. bis 06. Oktober 2012 in Halle (Saale).
ISBN 978-3-944507-01-9, ~~€ 49,00~~ € 24,00

Band 11/2014 Harald Meller/Roberto Risch/Ernst Pernicka (Hrsg.),
Metalle der Macht – Frühes Gold und Silber. *Metals of power – Early gold and silber.*
6. Mitteldeutscher Archäologentag vom 17. bis 19. Oktober 2013 in Halle (Saale).
ISBN 978-3-944507-13-2, € 119,00

Band 12/2015 Harald Meller/Helge Wolfgang Arz/Reinhard Jung/Roberto Risch (Hrsg.),
2200 BC – Ein Klimasturz als Ursache für den Zerfall der Alten Welt? *2200 BC – A climatic breakdown as a cause for the collapse of the old world?*
7. Mitteldeutscher Archäologentag vom 23. bis 26. Oktober 2014 in Halle (Saale).
ISBN 978-3-944507-29-3, € 109,00

Band 13/2016 Judith M. Grünberg/Bernhard Gramsch/Lars Larsson/Jörg Orschiedt/Harald Meller (Hrsg.),
Mesolithic burials – Rites, symbols and social organisation of early postglacial communities. *Mesolithische Bestattungen – Riten, Symbole und soziale Organisation früher postglazialer Gemeinschaften*
International Conference Halle (Saale), 18th–21st September 2013.
ISBN 978-3-944507-43-9, € 81,00

Band 14/2016 Harald Meller/Hans Peter Hahn/Reinhard Jung/Roberto Risch (Hrsg.),
Arm und Reich – Zur Ressourcenverteilung in prähistorischen Gesellschaften. *Rich and Poor – Competing for resources in prehistoric societies.*
8. Mitteldeutscher Archäologentag vom 22. bis 24. Oktober 2015 in Halle (Saale).
ISBN 978-3-944507-45-3, € 89,00

Band 15/2016 Harald Meller/Alfred Reichenberger/Christian-Heinrich Wunderlich (Hrsg.),
Alchemie und Wissenschaft des 16. Jahrhunderts. Fallstudien aus Wittenberg und vergleichbare Befunde.
Internationale Tagung vom 3. bis 4. Juli 2015 in Halle (Saale).
ISBN 978-3-944507-48-4, € 49,00

Band 16/2017 Harald Meller/Susanne Friederich (Hrsg.),
Salzmünde – Regel oder Ausnahme? *Salzmünde – rule or exception?*

Internationale Tagung vom 18. bis 20. Oktober 2012 in Halle (Saale).
ISBN 978-3-944507-11-8, € 75,00

Band 17/2017 Harald Meller/Falko Daim/Johannes Krause/Roberto Risch (Hrsg.),
Migration und Integration von der Urgeschichte bis zum Mittelalter. *Migration and Integration from Prehistory to the Middle Ages.*
9. Mitteldeutscher Archäologentag vom 20. bis 22. Oktober 2016 in Halle (Saale).
ISBN 978-3-944507-61-3, € 49,00

Band 18/2018 Harald Meller/Detlef Groneborn/Roberto Risch (Hrsg.),
Überschuss ohne Staat. Politische Formen in der Vorgeschichte. *Surplus without the State. Political Forms in Prehistory.*
10. Mitteldeutscher Archäologentag vom 19. bis 21. Oktober 2017 in Halle (Saale).
ISBN 978-3-944507-83-5, € 69,00

Band 19/2019 Harald Meller/François Bertemes (Hrsg.),
Der Aufbruch zu neuen Horizonten. Neue Sichtweisen zur europäischen Frühbronzezeit. Abschlusstagung der Forschergruppe FOR550 vom 26. bis 29. November 2010 in Halle (Saale).
ISBN 978-3-948618-03-2, € 59,00

Band 20/2019 Harald Meller/Susanne Friederich/Mario Küßner/Harald Stäuble/Roberto Risch (Hrsg.),
Siedlungsarchäologie des Endneolithikums und der frühen Bronzezeit. *Late Neolithic and Early Bronze Age Settlement Archaeology.*
11. Mitteldeutscher Archäologentag vom 18. bis 20. Oktober 2018 in Halle (Saale).
ISBN 978-3-944507-94-1, € 149,00

Band 21/2019 Harald Meller/Susanne Kimmig-Völner/Alfred Reichenberger (Hrsg.),
Ringe der Macht. *Rings of Power*
Internationale Tagung vom 09. bis 10. November 2018 in Halle (Saale).
ISBN 978-3-944507-97-2, € 79,00

Band 22/2020 Harald Meller/Roberto Risch/Kurt W. Alt/Francois Bertemes/Rafael Micó (Hrsg.),
Rituelle Gewalt – Rituale der Gewalt. *Ritual Violence – Rituals of Violence.*
12. Mitteldeutscher Archäologentag vom 10. bis 12. Oktober 2019 in Halle (Saale).
ISBN 978-3-948618-06-3, € 109,00

Band 23/2021 Falko Daim/Harald Meller/Walter Pohl (Hrsg.),
Von den Hunnen zu den Türken – Reiterkrieger in Europa und Zentralasien. *From the Huns to the Turks – Mounted Warriors in Europe and Central Asia*
Internationale Konferenz am Römisch-Germanischen Zentralmuseum – Leibniz Forschungsinstitut für Archäologie in Kooperation mit dem Institut für Mittelalterforschung der Österreichischen Akademie der Wissenschaften und dem Landesmuseum für Vorgeschichte Halle Mainz, 25.–26. April 2018
ISBN 978-3-948618-24-7, € 49,00

Erhältlich im Buchhandel oder direkt beim
Verlag Beier & Beran
Thomas-Müntzer-Straße 103
08134 Langenweißbach
Deutschland
Tel. +49 37603/36 88
verlag@beier-beran.de
https://archaeologie-und-buecher.de/