

2002

## Ancient Astronomical Alignments: Fact or Fiction?

Frank Prendergast

*Technological University Dublin, frank.prendergast@tudublin.ie*

Follow this and additional works at: <https://arrow.tudublin.ie/arastart>

 Part of the [Other Engineering Commons](#)

---

### Recommended Citation

Prendergast F. & Ray, T. (2002) Ancient Astronomical Alignment: Fact or Fiction? *Archaeology Ireland*, 16:2 (60 Summer) pp.32-35.

This Article is brought to you for free and open access by the Archaeoastronomy Research at ARROW@TU Dublin. It has been accepted for inclusion in Articles by an authorized administrator of ARROW@TU Dublin. For more information, please contact [yvonne.desmond@tudublin.ie](mailto:yvonne.desmond@tudublin.ie), [arrow.admin@tudublin.ie](mailto:arrow.admin@tudublin.ie), [brian.widdis@tudublin.ie](mailto:brian.widdis@tudublin.ie).



This work is licensed under a [Creative Commons Attribution-NonCommercial-Share Alike 3.0 License](#)



€5.02 £3.95stg ISSN 0790-892x Volume 16 No. 2 Issue No. 60

Summer 2002

# Archaeology

## I R E L A N D



## Astronomical alignments

A curative cult in County Tipperary

Antiquities from holy wells







F. Prendergast, Department of Geomatics, Dublin Institute of Technology, and T. Ray, School of Cosmic Physics, Dublin Institute for Advanced Studies, consider the 'mongrel science' that is archaeoastronomy.

# Ancient astronomical alignments: fact or fiction?

If you are one of the privileged few to witness the light show in Newgrange on the shortest day of the year, you cannot fail to be impressed. But how do we know that its builders intended this sight? Could it after all have been an accident and are we reading too much into it? To answer questions like these requires knowledge not only of archaeology and astronomy but also of surveying techniques and statistics. Archaeoastronomy (as it is known) is very much a mongrel science, perhaps explaining why its pedigree is so often questioned! Extravagant and scientifically questionable claims have been made in its name, and many of its 'theories' are nothing more than wild flights of fancy. That said, one must look coldly at the facts and, after applying rigorous scientific analysis, see whether heavenly bodies were important to prehistoric man.

Although it has been argued that various sites are aligned with the moon or bright stars, most studies have concentrated on testing for solar alignments. We will therefore primarily

look at the case for solar alignments in an Irish context. To appreciate what is meant by an alignment we first have to understand the complex movements of the sun.

## Tripping the light fantastic

As most people know, the sun's motion in the sky is complicated by the tilt of the earth. Without the tilt, there would be no seasons: the sun would rise and set in exactly the same place. No doubt the weather in Ireland would be less changeable as a consequence and not the interminable topic of conversation that it is! Instead in summer the sun rises in the north-east and sets in the north-west, while in winter it rises in the south-east and sets in the south-west. All of this is well understood.

Now imagine that you go out every morning for a year and measure the point of sunrise, starting in the autumn. Let us also suppose that you have a perfectly clear horizon. As the hours of daylight decrease, the sun will be observed to rise further and further south until on the 'shortest' day of the year it

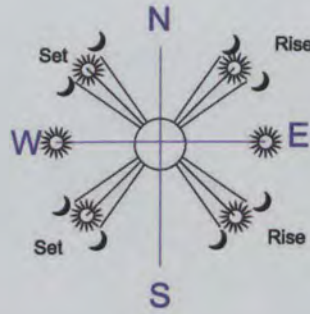
reaches its most southerly limit. Rather like throwing a stone up in the air, the sun's motion then comes to a standstill before it reverses direction. This standstill is known as the winter solstice (the word 'solstice' coming from the Greek for 'standing sun'). For a few days on either side of the solstice, the sun rises in more or less the same position to the naked eye. Then, as the 'days' get longer, the sun ascends from a point further north until, in the spring, it rises almost exactly due east. Now day and night are equal: we are at the spring equinox. Next, in midsummer, on the 'longest day' of the year, it reaches its most northerly point: again the motion of the sun on the horizon appears to slow down and we have arrived at the summer solstice. After that, the sun again reverses its path, rising due east at the time of the autumn equinox, and the cycle then repeats itself.

Next to the sun, the most conspicuous astronomical object in the sky is the moon. Since the moon's orbit around the earth is almost parallel to the earth's orbit around the



sun, the moon's extreme rising and setting points on the horizon closely follow those of the sun. That said, there is a  $5^\circ$  tilt between the two orbits and this separates the moon's standstill points, from the solstices (see right). When the moon reaches its most extreme northerly rising and setting points or its extreme southerly rising and setting points, it is said to be at a major standstill.

In principle, then, testing whether a monument is aligned with, say, the summer solstice sunrise point should be a relatively straightforward matter. There is, however, an additional complication that we have to allow for when looking for solstitial alignments: the change in the tilt of the earth's rotation axis with time. The earth is rather like a child's spinning top and, like a top, its axis can wobble under the influence of gravity. In the case of the child's top the gravitational force comes from the earth, but in the case of the earth itself the pull comes from the other bodies in the solar system. For example, 5000 years ago, when the great monuments of the Boyne Valley were built, the earth's tilt was approximately  $24^\circ$ , as opposed to  $23.5^\circ$  today. The longest day of the year would have been slightly longer and the shortest day correspondingly shorter. It also means, for example, that the point where the sun rose on the shortest day of the year was somewhat further south in Neolithic times than at present. How much further depends on latitude, but in the case of Ireland sunrise and sunset on the longest and shortest days of the year would have been about a degree away from where they occur now, i.e. roughly two solar diameters. When testing for solstitial alignments, then, you have to check whether these occurred when the site was built. As we shall see, Newgrange is a classic example of a site that was better aligned in the past than today.



### Lies, damned lies and statistics

We do not have the manuals for prehistoric sites, so it is hard to know what precisely was in the minds of their builders. In archaeoastronomy one plays a statistics game: the question has to be asked, in an unbiased way, what the chances of a particular alignment are. Being unbiased is the tricky bit; there is not much point in finding an alignment and then, after the fact, asking what is the probability of it occurring randomly. That is like winning the Lotto and then working out how unlikely your win is! One way we can try to avoid bias is to look at a site in the context of other similar monuments locally or regionally. Collectively do we see similar trends, and can these be identified with astronomically important positions? Only then are we on a firm footing when claiming the sun was important in their layout.

A hypothetical experiment will make this point clearer. Suppose we take the plans for a recumbent stone circle, like the one at Drumbeg in Cork, and store it on a computer. With the computer we can spin the stone circle around like a roulette wheel and so randomly orientate it in space. Let's also make things simple and take the horizon to be clear in all directions. Now a recumbent stone circle has one main axis (from the recumbent stone to the portals), although the horizon can be viewed in either direction. If

the circle is 10m wide, say, and the recumbent stone 1m across, then the angle defined by the stone on the horizon is about  $6^\circ$  as seen from the portals. Assuming a random orientation, there is a  $6^\circ/360^\circ$  or one in sixty chance that the axis of the stone circle will 'hit' upon the place where the sun rises on the summer solstice. But an 'astronomical alignment' might equally be claimed if it hit on the corresponding sunset point, or the winter solstice sunrise or sunset points, or even the equinoxes. The chance of a purely random 'solar alignment' then becomes one in twelve. Good betting odds, perhaps, but hardly the basis for a scientific theory! In such cases it is important to collectively study a set of monuments to search for preferred directions. Stone rows represent a classic example.

### The stone rows of Ireland

The Irish landscape is well endowed with stone rows—prehistoric linear settings of regularly spaced upright stones. These are found mainly in three concentrations—Cork and Kerry, the west of Ireland and mid-Ulster—and some consist entirely of quartz. There are more than 100 short rows and pairs and in excess of 80 long rows in the south of Ireland. The west of Ireland has more than 30 rows. Row lengths vary from 3m to over 13m. They are sometimes located close to stone circles and they may have outliers. Many have stones graded in height from one end of the row to the other and, in conjunction with an analysis of the horizon, this suggests a preferred viewing direction (see photo). They are generally found in the uplands and they belong to the wider western European tradition of ceremonial monuments consisting of pairs, short rows, long rows, avenues and multiple rows. The few that have been excavated have provided very few artefacts but have yielded dates consistent with construction from about 1900 to 900 BC, i.e. early to middle Bronze Age.

Such simple morphologies are a mysterious legacy from the distant past, challenging archaeologists and archaeoastronomers to decode their meaning and purpose. There are many theories—were they erected as route or boundary markers, astronomical

Far left: Killadangan stone row at sunset and during daylight (photos by Chris Corlett).

Above: Solar and lunar standstills.

Left: Sunrise at Newgrange.





alignments, sites for ritual practice, or as alignments towards mountains or hills considered sacred to those who erected them?

The results of preliminary archaeoastronomical research on the stone rows of the south-west and west of Ireland are providing new and complementary insights into the intentions of the monument-builders. In the south-west there is an overwhelming NE/SW trend in the orientations. More detailed analysis, however, reveals no special interest in the sun. Instead there is strong statistical evidence that the alignments show a preference towards the southern and northern major lunar standstills, and also with the setting full moon nearest to midsummer. These findings are consistent with the evidence arising from similar studies of stone rows in Scotland. By allowing all of the site survey data to 'speak for themselves', as it were, additional new findings have emerged through complex computer modelling techniques of the relationship between the monuments and their indicated horizons locally. Apart from a symbolic interest in the moon, studies of the rows of south-west Ireland additionally show that many were oriented on prominent topographic features such as hills and mountains. This suggests that horizon features may also have played a role in the symbolism associated with the location of some of the stone rows, in addition to an interest in the rising or setting of prominent celestial bodies.

The west of Ireland stone rows are more problematic in terms of archaeoastronomy. The sites at Gleninagh, Kiladangan and perhaps Sheeauns are closely aligned to the setting sun at the winter solstice. That said, a quarter of the sites have orientations associated with the southern lunar standstill. And even more intriguingly, another quarter exhibit orientations which are approximately due south within a degree. More detailed

investigations are under way to discover whether this might be indicative of an interest in the culmination of certain astronomical bodies or simply an orientation on symbolic topographical features.

### **The great Boyne Valley monuments: east is east and west is west, but . . .**

Most readers will be familiar with the three great burial mounds of Newgrange, Knowth and Dowth in the Boyne Valley. All of these sites were originally built approximately 5000 years ago. The most famous, at least from an astronomical perspective, is of course Newgrange. As is well known, Newgrange has a roof-box over its entrance which allows sunlight to penetrate into the main chamber around the time of the winter solstice. The alignment itself is virtually perfect for the period in which it was built: then on the shortest day of the year sunlight would have entered the main chamber precisely at the time of sunrise, whereas today one has to wait approximately eleven minutes after the sun appears over the horizon to witness the same phenomenon. Moreover, sunlight would have originally penetrated right to the back of the monument, something which it no longer does, as the sun would have been that bit

lower on the horizon at 'first light'. The alignment is so perfect that there can be no doubt it was deliberate. What about Knowth and Dowth?

Knowth and Dowth, unlike Newgrange, have two passages into each mound. In the case of Knowth, the passages are diametrically opposite each other and lie approximately east-west. Dowth has one short passage pointing roughly south-west and another with a more westerly aspect. It is sometimes claimed that Knowth is aligned with the equinoxes and that the south-western passage at Dowth is lined up with the setting sun on the winter solstice. A cursory examination of the ground-plans of both sites might lead one to suspect that there might be some substance in the speculations concerning Knowth, particularly the western passage, but not in the case of Dowth. We carried out a quick survey of both sites, with the permission of Dúchas, and to our surprise learned a salutary lesson on the confusion that can ensue when archaeologists and surveyors meet!

The south-western passage at Dowth is short, only 3.3m long, leading into a circular chamber 4.5m in diameter with a large recess off to the east. At the entrance to the passage is a kerbstone that is currently lying face down but presumably was upright when the monument was first built. The kerbstone is one of 115 still known to exist and, judging by the ground-plan, the mound may originally have had twice this number. We found the central axis of the passage and main chamber to point to an azimuth of 217° (measuring clockwise from north). Without going into details, it suffices to say here that this passage points crudely towards the winter solstice sunset, as suspected locally. One would never have guessed this, however, by looking at the original ground-plan as the angle of the passage with







'...we have to look at the case for astronomy within the much broader context of the culture, landscape and climate in which a monument was built'

respect to north appears to be entirely different. It took a few moments to realise that *magnetic north* rather than *true north* is marked on the plans! The angular difference is large since the original maps were made in the 1960s and magnetic north at that time was approximately 12° west of true north. Today the difference is only half that value. Clearly there is no point in giving magnetic north in a map if you do not specify that it is magnetic north and when the measurements were made! Turning to Knowth, we found a similar trail of confusion.

The ground-plan of Knowth clearly suggests that the western passage (or at least most of it up to some 30m from the entrance) points towards sunset on the equinoxes, assuming a clear, low-altitude horizon—that is to say, the majority of the passage would appear to lie almost exactly west. Both timed solar and gyrotheodolite measurements, however, showed the azimuth of this passage to be 258.5°, i.e. 11.5° south of true west or 23 solar diameters. This again implied that magnetic rather than true north was used for the ground-plans. When the sun sets in this direction, we are a fortnight away from the equinoxes!

In some literature, and partially because of the confusion between magnetic and true

north, it is emphatically claimed that both of the passages at Knowth (the outer section in the case of the western passage) are precisely orientated on sunrise and sunset at the equinoxes. Supporting diagrams often show an exact east–west orientation for both passages. In the case of the main eastern passage, its azimuth, as measured by the authors, is actually 85°, i.e. 5° north of east or roughly nine solar diameters on the horizon. Such a large deviation from due east most certainly does not constitute a solar equinoctial alignment. Moreover, given the elevated horizon beyond the entrance, the sun actually rises south of east at the equinoxes, making the difference even less favourable.

And as for the significance of the equinoxes, to Neolithic and Bronze Age people in western Europe at any rate, we must temper our conditioned 21<sup>st</sup>-century ideas and consider the following: the summer and winter solstices are observable events on the horizon, as explained earlier. The equinoxes, however, occur at the midpoints between the solstices. Apart from the technical challenge of determining such a direction, there is the cultural question of the significance of the equinoxes to an agrarian society. There remains the inescapable fact that only a very small number of monuments show a preferred orientation either due east or west, not only in Ireland but also in the rest of western Europe. The scientific jury is still out on this very contentious issue.

### The stars and the stones

There are many dangers inherent in attempting to match the alignment of monuments or

selected components of monuments with prominent stars. Although the solstitial positions on the horizon change very slowly with time, the rising (and setting) positions of stars alter typically by 15° in 5000 years. It is therefore relatively easy to assign a stellar explanation to any selected alignment by choosing a 'suitable' date for the construction of the monument. Alternatively, and because of the very large number of stars available, the modern researcher armed with a computer will inevitably find one such star that seemingly fits the alignment theory. That particular line of investigation has many red-faced casualties!

### Conclusions

One has to be careful when testing whether a site is astronomically aligned. There are many factors to take into account, including its age, the accuracy of any potential alignment, case studies of other similar monuments locally and regionally, and the archaeological evidence. In the collection and analysis of site data, the use of proper scientific methodologies is a critical consideration. Some 50 years ago, the archaeologist Seán Ó Riordáin 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'. To paraphrase a well-known political leader from the north of this island, 'They [the extravagant protagonists] have not gone away'!

Statistical arguments and unbiased surveys of large numbers of monuments are often required to rigorously check the astronomical hypothesis. Moreover, we have to look at the case for astronomy within the much broader context of the culture, landscape and climate in which a monument was built. Meaningful studies of Irish monuments have proven to be very fruitful. Whereas some thirty years ago archaeology may have been primarily focused on site-specific and detailed excavations, it is fair to say that modern archaeology has now firmly shifted towards the much wider analysis of people, society and landscape, with sites and monuments perceived as components. Archaeoastronomy has made a meaningful contribution to this paradigm shift. ■

Above left: Bohonagh stone circle, Co. Cork: oriented on equinoctial sunset.

Below left: Knockaunbaun stone row (quartz), Co. Galway: landscape and monuments, people and sky.

Above: Gleninagh stone row, Co. Galway: oriented on winter solstice sunset.