

## Introduction

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Whether in the form of hidden codes, ancient mysteries, or perplexing conundrums, enigmas astonish and confound, but they also entice. Enigmas challenge us to ask new questions and explore novel angles of analysis. They are at the core of processes of enquiry and vital to humanity's attempts to understand the world and our place in it.

Accepting that there is no definitive answer is a humbling but often essential component of research and, indeed, of human life. The writer Douglas Adams famously satirised humanity's incessant search for conclusive answers in *The Hitchhiker's Guide to the Galaxy*. After having spent millions of years contemplating The Ultimate Question of Life, the Universe, and Everything, the supernatural computer Deep Thought eventually concludes the Ultimate Answer to be '42'. Pushed further, Deep Thought defends this answer, stating 'I think the problem, to be quite honest with you, is that you've never actually known what the question was.' As Adams's parody implies, asking the right questions can be crucial when dealing with enigmas. This is part of what makes these puzzles so compelling, the hope that revisiting an enduring problem from a unique angle or engaging with diverse perspectives may lead to fresh insights.

That hope may well be what motivated physicist Richard Feynman to suggest 'all good theoretical physicists put [137.0359...] up on their wall and worry about it'.<sup>1</sup> The number mentioned is the inverse of the fine-structure constant, which governs the strength of the interactions between, for example, light and charged particles such as electrons. As Feynman put it, 'Immediately you would like to know where this

<sup>1</sup> R. P. Feynman, *QED: The Strange Theory of Light and Matter* (Princeton, NJ: Princeton University Press, 1985).

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number for a coupling comes from ... Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding by man.' A real-life rival of 42?

Since antiquity, wisdom has been handed down in the form of enigmas, as riddles and puzzles which defied easy interpretation. The word itself derives from the Latin *ænigma* and Greek *ainigma*, both meaning 'riddle'. Its etymological roots can be traced to the idea of speaking allusively or obscurely (*ainíssessthai*) and the concept of a fable or proverb (*aînos*).<sup>2</sup> In the late seventh century, Aldhelm (d. 709/710), the abbot of Malmesbury in Wiltshire and then bishop at Sherborne in Dorset, amassed 100 riddles in a collection called *Enigmata*.<sup>3</sup> Many of his riddles are still enjoyable brainteasers today, as in the following example (the answer to which can be found in the footnote):

From two materials, palms moulded me.  
 My insides glow; these guts – for sure a looting  
 Of flax or some thin reed – shine brilliantly,  
 Though flesh produced from flowers yellows now.  
 They're belching fire as flames and sparks are shooting,  
 And maudlin tears keep dripping down my brow,  
 So I still clear night's shadows that I feared;  
 They leave ash smudges where my guts were seared.<sup>4</sup>

Aldhelm's collection, which circulated widely throughout the Middle Ages, demonstrates the persisting intrigue of enigmas as well as their power to delight. Five centuries after Aldhelm's death, another monk writing from the same abbey, William of Malmesbury, praised his predecessor's work as 'a display of sport combined with artfulness, and eloquent and vigorous expression accompanied matter of little import'.<sup>5</sup> Some of the enigmas discussed in this volume are, like Aldhelm's riddles,

<sup>2</sup> T. F. Hoad (ed.), *The Concise Oxford Dictionary of English Etymology* (Oxford: Oxford University Press, 1996).

<sup>3</sup> See, for example, London, British Library, Royal MS 12 C xxiii, [www.bl.uk/collection-items/aldhelms-riddles](http://www.bl.uk/collection-items/aldhelms-riddles).

<sup>4</sup> *Saint Aldhelm's Riddles*, trans. A. M. Juster (Toronto: Toronto University Press, 2015), no. 52, p. 31. Answer: candle.

<sup>5</sup> William of Malmesbury, *Gesta Pontificum Anglorum: The History of the English Bishops*, 2 vols., ed. and trans. Michael Winterbottom and Rodney Thomson (Oxford: Oxford University Press, 2007), vol. I, p. 519.

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deliberate creations of human minds. Others, like the volcanoes which form the subject of Tamsin A. Mather's chapter, exist on a timescale which surpasses humanity's history. What they all share is the same propensity to fascinate, encouraging us to investigate further, hopeful of shedding further light on obscure problems or of solving difficult puzzles.

Historians often use the adjective 'enigmatic' to describe sources of uncertain provenance, perplexing content, or ambiguous meaning and purpose. One of the most well-known medieval enigmas is the fifteenth-century codex known as the 'Voynich Manuscript'.<sup>6</sup> Written in an unknown script accompanied by striking images, the manuscript has yet to be deciphered, despite the best efforts of experts in the century since Wilfrid Voynich discovered the text in 1912. The Holy Grail is another legendary enigma from the Middle Ages, first appearing in an Old French verse romance written by Chrétien de Troyes in the late twelfth century and infamous for its association with the mythical King Arthur and his court.<sup>7</sup> The Grail provides an apt metaphor for the methodology of approaching enigmatic problems. A mysterious object attracts attention, inspiring quests to discover it and often leading those seeking it down new paths on unexpected adventures. The eight chapters which follow reveal something of the innovative methodologies which are often required to uncover more about mysterious items and subjects. Some of the authors even share a little of the personal journeys (or quests!) which were a crucial part of the process of research, experimentation, and discovery.

Enigmas resonate with the processes and methodologies of research practices across the arts, sciences, and humanities. The topic's applicability across different disciplines made it an ideal theme for the Darwin College Lecture Series convened at the University of Cambridge between January and March 2020. The chapters in this volume derive from that lecture series. Despite the role of 'the enigmatic' as our contributors' guiding light, we were still surprised by the way in which the eight essays have naturally ended up speaking to each other. The authors cover

<sup>6</sup> Raymond Clemens (ed.), *The Voynich Manuscript*, with an introduction by Deborah Harkness (New Haven, CT: Yale University Press, 2016).

<sup>7</sup> Chrétien de Troyes, *Arthurian Romances*, trans. W. W. Kibler and Carleton W. Carroll (Harmondsworth: Penguin, 1991).

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a range of concepts, problems, and phenomena to explore the idea of enigmas from multi-disciplinary perspectives. They draw out several key themes in how researchers have approached puzzles and mysteries and what these can tell us about humanity and the world around us. Together, these chapters show that investigating and resolving enigmas opens new possibilities for interpreting the physical world, the material records of the past, and even our own emotions.

A fundamental paradox lies at the heart of human life: humanity considers itself unique despite biological, genetic, and evolutionary evidence to the contrary. In Chapter 1, Adam Rutherford explains how many of the traits and behaviours once considered exclusively human are, in fact, common beyond our species. We are not the only genus that communicates. Animals make use of a range of tools, even fire. Several other species have sex for reasons other than procreation. Is humanity really that enigmatic in comparison with other organisms, especially when our existence relies on a shared code – DNA? Rutherford argues that cultural accumulators, and especially the sharing of ideas, are crucial pieces in the puzzle of humanity’s evolutionary distinctiveness.

Enigmas of humanity provide a linking theme across several of the essays. Albert Yu-Min Lin, in collaboration with Derek Lomas, returns to the paradox of humanity’s uniqueness as a species in Chapter 8, which concludes the volume. Focusing on human capacity to design, Lin and Lomas draw attention to the fascinating role imagination can play in human life. The relationship between human consciousness and the evolution of the species continues to captivate and puzzle scholars. In the initial lecture of the very first Darwin College Lecture Series in 1977, the philosopher Karl Popper sought to unravel some of the mysteries of this subject by discussing ‘Natural Selection and the Emergence of Mind’. By revisiting the dialogue between consciousness and evolution, Lin and Lomas demonstrate how enigmas often necessitate dynamic collaboration between sciences, arts, and humanities. Archaeology provides evidence that the drive for diverse conscious experiences is no new phenomenon, while neuroscience illuminates the ways in which altered states of consciousness can enhance the variety of mental experience. Possible regional diversities in human imagination indicated by ethnobotanical and anthropological observation are placed alongside neuroimaging techniques, such

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as hyperscanning and biosensing, which reveal the brain's rhythmic nature. Art, design, and cognitive technologies can build on this picture by providing innovative ways of exploring conscious experience. Inspired by insights from a range of academic disciplines and reflecting on personal experience, this chapter proposes the role of 'harmony' as another enigmatic angle of research with potential to shed further light on the functioning of both human society and the human mind.

An important distinction can be made between puzzles which require enigmatic solutions and 'true mysteries', as Sean M. Carroll points out in Chapter 2. His chapter guides the reader through three related enigmas of modern physics. The first is a mystery of quantum mechanics. Despite the paradigm of quantum mechanics being pivotal to modern physics since it was put into place around 1927, important aspects of it are still not truly understood. Competing theories have been proposed, including the Many-Worlds approach, which Carroll argues fits well with other ideas at the forefront of modern physics. The second enigma is the emergence of spacetime, especially the way it interacts with gravity. Rather than following the traditional methodology of 'quantising' classical theories, Carroll proposes an alternative approach and instead seeks gravity within quantum mechanics. The chapter concludes with a discussion of the mystery of the arrow of time: what distinguishes the past from the future? Together, these three mysteries of modern physics serve as an important reminder of the endurance of enigmas in the very foundations of scholarly fields. Re-examining founding principles can provide a constructive alternative means of investigating mysteries, not only in modern science but also across other disciplines.

Enigmas not only occupy scholars in universities and academia; they also entice and fascinate researchers across a wide range of other spheres such as journalism, technology, and business. In Chapter 3, Jo Marchant shows how collaboration between different fields can sometimes prove the most fruitful way of unravelling mysteries. The chapter focuses on the fragments of a unique machine surviving from around 70–60 BC, known as the Antikythera mechanism. The efforts to decode this mystery extend more than a century since its discovery among the finds excavated by sponge divers from an ancient shipwreck off the coast of the island of Antikythera. Although the first experts who looked at the device were

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baffled by its gear mechanisms, dating, and purpose, Marchant explains how many of these inscrutable aspects slowly came to be clarified and solved. The initial process of deciphering the device's context and functions relied on a historian of science's fascination with ancient technology, an epigrapher's command of Greek inscriptions, and a radiographer and their X-ray machine. In the 1980s, the partnership between an amateur mechanic and a historian of computing enabled more data on the mechanism to be gathered from images taken with a crude tomography machine. But it was not until the early 2000s, when a filmmaker convinced a multinational information technology company to lend its support, that the device's remaining inscriptions could finally be read more fully. As well as illustrating the immense efforts it can take to 'solve' an enigma, Marchant's chapter displays the valuable insights which can come from these endeavours. The process of decoding the Antikythera machine challenged common assumptions about technological skill and astronomical knowledge in antiquity, but it also encouraged innovations in modern technology and revealed something of humanity's search to understand the cosmos.

Humans are skilled in producing enigmas. Sometimes these are ancient mysteries unintentionally left behind in the historical record but, as Chapter 4 shows, humans also deliberately engineer enigmas to serve their own purposes. Moving to the historical context of the twentieth century, James Grime reminds us that puzzles and codes have multifaceted uses in practices of concealment, especially for militaristic purposes, corporate secrecy, or national security. The term 'Enigma' is perhaps most recognisable in modern history and contemporary culture as the name of a cipher device used by the German military to send messages during World War II. Although the Nazis believed that the code produced by the Enigma machine was unbreakable, it was eventually cracked through the efforts of Polish and British code breakers. Focusing on the mathematics underpinning the story of the Enigma machine, this chapter sets out the process both of the code's creation and of its decryption. Grime recounts how Alan Turing, a mathematician and one of the code breakers at Bletchley Park, built on Polish efforts in the 1930s to help solve the cryptic puzzle. Turing assisted in the invention and design of the 'bombe machine' which, through a process of mathematical elimination, was able to break the Enigma

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machine's code. In this chapter, we see, once again, the necessity of collaborative labours when attempting to make sense of the most challenging problems. Yet Turing's story also emphasises that individual research and investigation can make a significant contribution by resolving crucial pieces of a much larger puzzle.

Describing someone as an enigma is often intended as a compliment, yet a mysterious facade is not solely an enthralling social quality. In Chapter 5, Tiffany Watt Smith focuses on the enigmatic nature of emotions and considers several different scenarios in which the act of deliberately hiding one's feelings can become an intentional strategy of defiance or defence. Although twenty-first-century social and cultural norms habitually expect a level of emotional legibility, detecting and interpreting others' emotions is never a straightforward task. By challenging some prevalent assumptions about emotions and their detection – such as the reliance on facial recognition algorithms or the belief that emotions are universal – Watt Smith judiciously reminds us that simplification is rarely the solution to an enigmatic phenomenon. Emotions are far more complex and entangled than has often been appreciated. They are also shaped by pervasive and often invisible cultural and political forces, as the first half of the chapter shows with reference to anthropological and historical examples. The second half of the chapter provides detailed examples in which the art of being emotionally enigmatic is employed as a deliberate tactic to provide protection in the face of hostility.

That we can observe enigmas even in seemingly quotidian situations, whether emotional interactions or the practice of writing, is equally relevant to Erik Kwakkel's study of medieval letter forms in Chapter 6. As Kwakkel points out, the process of designing and producing medieval books preserved historical information in both apparent and enigmatic forms. The words written by medieval scribes were, primarily, a method of conveying an evident meaning, but the shapes of the letters themselves also contained far subtler, hidden information. One of the central puzzles often faced by palaeographers is how to corroborate conclusions concerning a manuscript's provenance: how old is it, and where was it produced? While quantitative codicological studies, focused on the design aspects of medieval books, have provided indispensable insights to aid scholars in answering such questions, quantitative palaeographical studies are much

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rarer. Yet Kwakkel shows that studying elements of the configuration of medieval letters, especially stroke variability, can provide a new way of approaching some of the conundrums at the very centre of our understanding of medieval books. This alternative, quantitative approach to medieval letters challenges time-honoured principles of mapping medieval script families, but it also has the potential to make some of the most puzzling features of the development of medieval letters a little less enigmatic.

Chapter 7 takes us from enigmas in the everyday to an extraordinary natural object: volcanoes. Tamsin A. Mather examines some of the most enigmatic features of volcanoes and the roles they have played in the evolution of life on Earth. Valuable information can be collected from volcanoes such as Masaya in Nicaragua, which secretes gas emissions from its vents. When analysed, these data provide insights into the inner workings of our planet's hidden centre. Mather's chapter first considers how volcanic events have shaped the physical environment around us, providing examples of large igneous provinces, like the Columbia River flood basalt produced by layers of lava flowing over a huge geographical area 17 million years ago. These remarkable events have also contributed to Earth's atmosphere and climate, as more recent volcanic eruptions show in miniature. Trying to scale up present-day examples to help understand the impact of events which happened millions of years ago is one of the challenges of studying volcanism. Mather explains some of the ways researchers today are tackling this puzzle. Like many of the other chapters in the volume, this is an evocative story of how an enigmatic subject – whether a natural structure such as a volcano, an intriguing item such as the Antikythera mechanism, or a theoretical question underpinning an entire discipline – can capture the mind and inspire years of research in the hope of uncovering more about the world around us.

The 2020 Darwin College Lecture Series coincided with the onset of the Covid-19 pandemic across the world and its arrival in the United Kingdom. The eighth and final lecture of the series took place on Friday 6 March, only a few weeks before the first UK-wide lockdown came into force. The pandemic demonstrates, in all too stark reality, the negative impact of an enigmatic problem: a virus about which little was known spread rapidly



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throughout the global population. This exceptional event quickly altered day-to-day existence for many across the world and leaves a lasting impression on communities and individuals. Responses to the crisis share many of the features the authors of this volume have considered when addressing past and present enigmas. The search for a vaccine required new questions to be formed and deliberated as well as the design and production of innovative technologies. Collaboration across disciplines and between fields has been necessary to understand the full impact of this virus, which has had a range of physical, psychological, economic, social, and cultural consequences. And the extraordinary nature of this problem has permeated even the everyday. Although some enigmas can, at first glance, seem insurmountable in the challenges they pose to humanity, the overall impression provided by this volume is one of hope. Even problems that initially appear overwhelming can be scrutinised, interpreted, and ultimately resolved.

## 1 Human Origins

ADAM RUTHERFORD<sup>1</sup>

‘What a piece of work is a man!’ marvels Hamlet, in awe at our specialness:  
‘How noble in reason! How infinite in faculty!  
In form, in moving, how express and admirable!  
In action how like an angel!  
In apprehension how like a god! The beauty of the world!  
The paragon of animals!’<sup>2</sup>

The paragon of animals is a prescient phrase. Two and a half centuries after Shakespeare wrote those words, Charles Darwin would irrefutably cement humankind’s position as an animal – the slightest of twigs on a single, incomprehensibly baffling family tree that encompasses four billion years and 100 billion species, all of them – of *us* – rooted in a single origin, with a shared code that underwrites our existence. The molecules of life are universally shared, the mechanisms by which we got here are the same: genes, DNA, proteins, metabolism, natural selection.

Hamlet then ponders the paradox at the heart of humankind: ‘What is this quintessence of dust?’ We are special, but we are also merely matter. We are animals, yet we behave like angels, or even gods. Another version of this sentiment comes from (an arguably less highbrow example of) modern culture, the Pixar animated superhero film *The Incredibles*: ‘Everyone is special . . . which is another way of saying that no one is.’

This paradox is at the root of who we are. The question of what makes humans special, or even whether we are exceptional, has preoccupied our species for thousands of years, especially in the major works of most

<sup>1</sup> For further discussion of the topics covered in this chapter, see Adam Rutherford, *The Book of Humans: The Story of How We Became Us* (London: Weidenfeld & Nicolson, 2018).

<sup>2</sup> William Shakespeare, *Hamlet*, Act II Scene II.