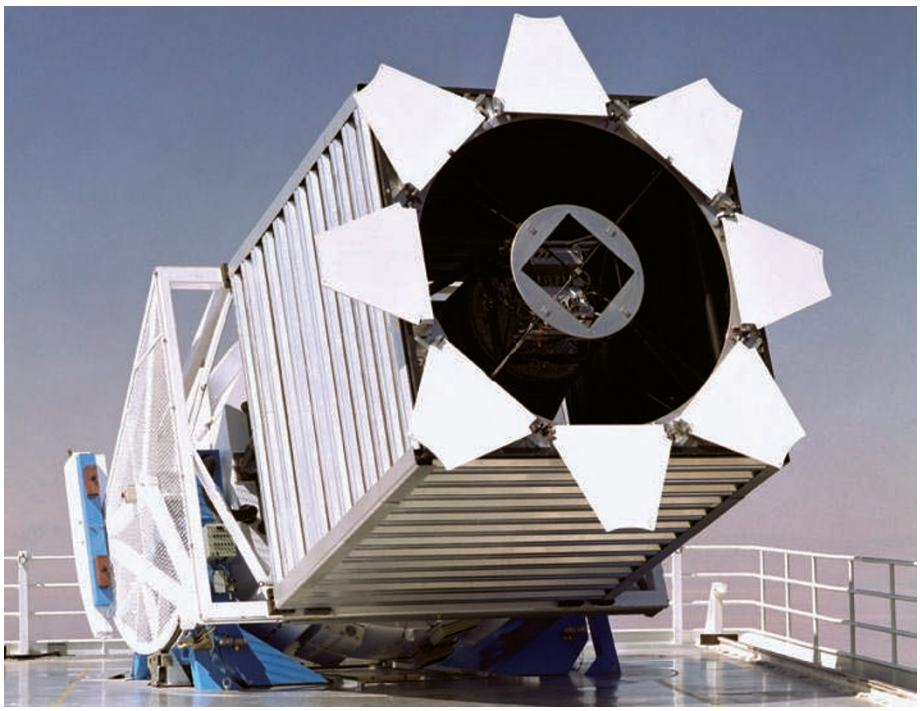
BOOKS & ARTS

Last days of the lone astronomer

A celebratory account of the Sloan Digital Sky Survey highlights astronomy's culture shift to big science — but at what risk to individual ingenuity, asks **Joss Bland-Hawthorn**?

A Grand and Bold Thing: An Extraordinary New Map of the Universe Ushering in a New Era of Discovery
by Ann Finkbeiner
Free Press: 2010. 240 pp. $27



SLOAN DIGITAL SKY SURVEY; WWW.SDSS.ORG

The Sloan Digital Sky Survey uses this innovative 2.5-metre telescope to scan the northern skies.

A hundred years ago, only a few astronomers had regular access to telescopes that allowed them to make the discoveries that built their formidable reputations. In the mid-twentieth century, social change gave rise to national observatories that served a far greater constituency. The past decade has seen another major shift in astronomy: the Sloan Digital Sky Survey has opened up the northern sky to anyone with a computer.

A Grand and Bold Thing tells the story of the Sloan survey, which has mapped and digitized hundreds of millions of galaxies using a dedicated telescope in the New Mexico desert since 2000. With unfettered access to e-mail archives, science writer Ann Finkbeiner offers a fly-on-the-wall account of this ambitious programme, from the politics of its formation to its eventual success as one of the most highly cited projects in astronomy.

The survey was conceived by astronomer James Gunn of Princeton University, New Jersey, after the launch of the Hubble Space Telescope, in which he was also involved. Frustrated that management clashes between universities and NASA had allowed the orbiting observatory to be flown with flawed optics (since corrected), he turned his attention to a scheme to map the brightness and spectra of millions of nearby galaxies.

Finkbeiner reveals the complex negotiations that were required to get the survey off the ground. A set of elite US institutions — Fermilab, Princeton and the Institute for Advanced Study — initially got together to secure funding for the project from the US National Science Foundation and the Alfred P. Sloan Foundation. Several more university departments joined later. The different styles of the bodies involved led to near-fatal tensions within the project. "The trenches are dug, the war has started," remarked Gillian Knapp, a senior project scientist on the Sloan survey. Finkbeiner summarizes the factions succinctly: "Fermilab is intransigent, Chicago is disengaged, Princeton is arrogant."

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Fortunately, as the technology proved itself and the inevitable success of the project became clear, the organizations learned to work together.

The Sloan survey's power lies in the design of its telescope. After the eighteenth-century discovery by English astronomer James Bradley of stellar aberration — the shift in stars' positions due to the motion of Earth — improvements in differential measurement have heralded astronomical breakthroughs. The Sloan project is no exception. The telescope's precision in recording brightness in five bands of optical wavelength allows the accurate selection of objects from a catalogue of astronomical sources on the basis of their brightness and colour, from which physical trends and unusual objects can be derived. The telescope can scan much of the northern sky over several years with a camera that, a decade ago, was the largest of its kind.

Finkbeiner's explanation of the hardware is solid. She veers from the mundane to the unexpected, telling us, for instance, how the telescope once lost its tracking because of moths getting crushed on the instrument's drive. After experimenting with jangling keys and lasers, technicians found that two puffs of air per second kept the moths at bay. She describes many scientific results derived from the survey, such as measurements of galaxy clustering and the identification of distant quasars. But she emphasizes the contributions of US astronomers over those of others, writing Australian and UK scientists out of the discovery of quasars and 'acoustic' features in the distribution of local galaxies, for example. And a lack of quotes from outsiders means that we do not get a broad perspective of the survey.

The book highlights how the culture of astronomy is changing to one of 'big science'. Gunn has stated that "lone-astronomer days are over", with the subject becoming so vast that it can be tackled only by large groups armed with computer code. The origins of this 'industrialization' lie in part with one of Gunn's Princeton astronomy colleagues, the late Bohdan Paczynski. In the 1980s, he proposed that "dark compact objects" might act as gravitational lenses, temporarily brightening background stars by distorting their light as the compact masses moved in front of them. These one-in-a-million events should be detectable,

he suggested, by monitoring millions of stars with an automated telescope, a battery of computers and an automated software pipeline. A US–Australian team succeeded in detecting the objects by such a technique in 1993.

The emergence of a new generation of graduate students and postdocs who are "born wired to write code" is credited as essential to interpreting the vast data sets of modern astronomy. Astrocoders entertain us with their impressive films of stars falling into black holes, galaxies in collision and the birth and evolution of the Universe. Yet Finkbeiner does not explore the deeper question of how we should move from this information overload to physical understanding. With so many free parameters, it is debatable how robust these computer models are, what exactly we learn from them and to what extent they are falsifiable.

The availability of vast databases also affects the nature of the research. I fear for the loss of individuality in approaches and for niche projects that would otherwise open up new areas of exploration. Every new survey sparks a rush of comparisons with existing surveys at other wavelengths; this might exponentially boost the literature but it does not benefit our understanding to the same degree. Confirmatory results abound, and networked citations between groups foster a sense of success, irrespective of scientific outcome. As a result, there is huge pressure on individual astronomers to get involved with big projects or lose out.

Although *A Grand and Bold Thing* is more a celebration of Gunn's extraordinary career than a definitive account of the Sloan survey, it succeeds in capturing the arcane world of the professional astronomer. To Gunn's colleague at Princeton, Jerry Ostriker, it is almost a religious undertaking: "People will devote their lives, their time, their wits for things which have no practical importance. And there's something rather beautiful about that." ■

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Preserving social difference

What Makes Civilization? The Ancient Near East and the Future of the West
by David Wengrow
Oxford University Press: 2010. 217 pp.
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Every major war causes us to reflect on the meaning of the word civilization. The mayhem over the past decade in what was once Mesopotamia (now Iraq) is particularly provocative because the region is known as the historical birthplace of civilization. In *What Makes Civilization?*, archaeologist David Wengrow takes a 5,000-year perspective, comparing the first thousand years of the Mesopotamian and Egyptian civilizations to draw unsettling lessons about recent events.

The early glories of civilization developed in the third millennium BC (3000–2000 BC) in the 'Fertile Crescent' of the Middle East and beside the River Nile: city states such as Uruk and Ur in Mesopotamia, the pyramids at Giza and the development of sophisticated writing systems in cuneiform and hieroglyphics. Isaac Newton wrote in his *Chronology of Ancient Kingdoms Amended* (published posthumously in 1728) that ancient Mesopotamia and Egypt provided Europe with the earliest glimmers of the Enlightenment — farming, literacy, astronomy and navigation — as well as a darker heritage of sacred kingship and the dynastic cult of the dead.

Archaeologists have always debated the importance of borrowing and diffusion of ideas versus that of independent invention and national identity. There is a current fashion for exploring the interconnectedness of ancient civilizations, yet most archaeologists continue to focus on single regions. They agree with the striking insight of French sociologist and anthropologist Marcel Mauss, who wrote in his 1920 essay 'The Nation', after the First World War: "Societies live by borrowing from each other, but they define themselves rather by the refusal of borrowing than by its acceptance."

Mesopotamia and Egypt, despite their geographical proximity and similar locations in the flood plains of great rivers, provide a fascinating example of Mauss's observation. For all the impressive scale and sophistication of these two early civilizations, they developed in very different ways. Egyptian pyramid building and the mortuary cult of the pharaoh — with its mummies, lavishly painted tombs and 'books of the dead' — have no obvious equivalent in Mesopotamia. Writing was invented in the two regions at about the same time — in Mesopotamia as cuneiform around 3300 BC, and in Egypt as hieroglyphics in about 3200 BC — yet the two scripts look entirely different and seem to have arisen independently.

C. ONIANS/AFP/GETTY

Early Mesopotamian culture had little overlap with that of ancient Egypt, despite their proximity.

Astonishingly, there is no written evidence that ancient Mesopotamia and Egypt were directly aware of each other during their first 1,000 years of existence. However, both civilizations undoubtedly traded with areas farther afield well before the third millennium. For example, precious lapis lazuli, which must have come overland and by sea from its nearest source in mountainous Afghanistan, is found in Egyptian burials dating back to the fourth millennium BC.

These differences lend support to the separatist argument of Mauss, rather than to the idea of the growth of civilization as a universal and multicultural phenomenon. Although *What Makes Civilization?* does not deny the importance of mixtures and borrowings, it convincingly concludes that the parallel development of Mesopotamia and Egypt demonstrates "the deep attachment of human societies to the concepts they live by, and the inequalities they are prepared to endure in order to preserve those guiding principles". This finding does not bode well for the current wars in Iraq and Afghanistan. ■

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