

Touch the Invisible Sky: A multi-wavelength Braille book featuring NASA images

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Abstract

Multi-wavelength astronomy – the study of the Universe at wavelengths beyond the visible, has revolutionised our understanding and appreciation of the cosmos. Hubble, Chandra and Spitzer are examples of powerful, space-based telescopes that complement each other in their observations spanning the electromagnetic spectrum. While several Braille books on astronomical topics have been published, to this point, no printed material accessible to the sight disabled or Braille reading public has been available on the topic of multi-wavelength astronomy. *Touch the Invisible Sky* presents the first printed introduction to modern, multi-wavelength astronomy studies to the disabled sight community. On a more fundamental level, tactile images of a Universe that had, until recently, been invisible to all, sighted or non-sighted, is an important learning message on how science and technology broadens our senses and our understanding of the natural world.

According to the National Federation of the Blind, there are about 1.3 million legally blind persons in the United States with 93,600 of these persons being of school age. Students who are blind often face increased difficulty in obtaining educational materials. Books must have text translated into Braille, be read into audio files or have text pages made accessible for computer screen reading software. Illustrations are either audio described, recreated into tactile graphics, or completely eliminated. The time required to make the materials accessible can cause students to loose ground and fall behind their peers.

Why create a tactile book on wavelengths that are not accessible to human eyes? Tactile images of a Universe that, until recently, had been invisible to human eyes, is an important learning message on how science and technology broadens our senses and our understanding of the natural world.

Touch the Invisible Sky: A Multi-Wavelength Braille Book Featuring Tactile NASA Images brings images of astronomical objects observed at multiple wavelengths to the fingertips of visually impaired readers. The text pages have both print and Braille, with the colour images themselves overlaid with clear acrylic TechnoBraille®. *Touch the Invisible Sky* not only displays tactile images of previously unseen celestial objects, but also presents them in a “family album” style. Each celestial object is shown as a set of four multi-wavelength views so the reader can directly compare and explore distinctive features.

¹ www.blindscience.org

One major challenge with the development of such a book is a lack of familiarity with the objects even for readers who have a reasonable knowledge of astronomy. Whereas readers probably have a mental model of objects such as the planets or the Sun, images of supernova remnants or galaxy mergers, even at optical wavelengths, defy comparison with the familiar. The job of describing the key features in the images, and to bringing such esoteric, yet beautiful and powerful, images alive in the mind of the reader, required considerable care. The task of unlocking the story behind the image is just as important for the sighted reader as for the non-sighted.

The main body of the text begins with an introduction to wavelength and the electromagnetic spectrum. Tactile views and descriptions of Hubble, Spitzer, Chandra and an antenna from the Very Large Array radio telescope, introduce some of the equipment and techniques used to reveal new views of the cosmos. By showing cut-away illustrations of reflecting surfaces and light paths, the views highlight the similarities and differences in the technologies needed to detect light of hugely differing wavelengths and energies.

The celestial objects were chosen to give a flavour of the diverse nature of the Universe, from our own Sun to distant galaxies and the extreme Universe of supernovae and pulsars. The features revealed by the different wavelength ranges show how multi-wavelength observations can be synthesised to attain a deep understanding of the structure of astronomical objects and mechanisms that shape them.

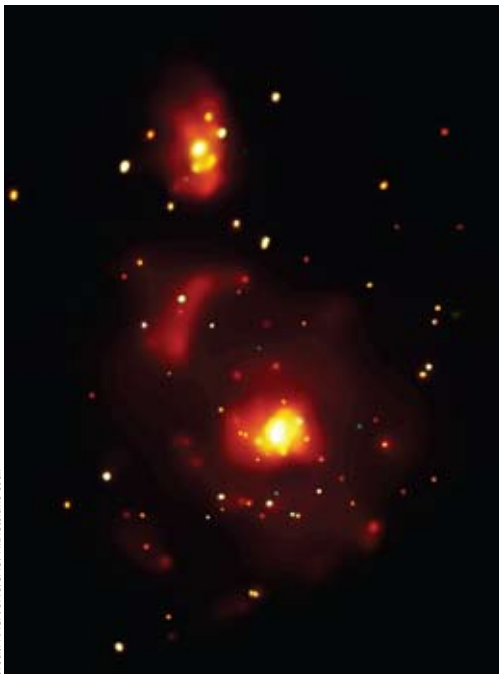


Figure 1 – M51Chandra: X-ray image of spiral galaxy M51



Figure 2 – TextureImage: Tactile outline for Chandra X-ray image of spiral galaxy M51

The exploration starts at the Sun, and highlights the role of magnetic fields in sunspots and solar flares. Images of the star Eta Carinae reveal the complex winds and ejecta that tell the story of the death throes of perhaps the greatest star in our galaxy. The Crab Nebula and Kepler's supernova remnant highlight the endpoint of stellar evolution, and the incredible idea that even stars live and die. Unimpressive in visible light, Kepler's Supernova Remnant comes together like a jigsaw puzzle when four wavelength bands are combined. And in X-ray light, the Crab's central pulsar engine, one of the most bizarre objects in the Universe, shines brightly.

Moving out to the realm of the galaxies, multi-wavelength views of the famous Whirlpool Galaxy bring out vastly different features, from the giant dust lanes to magnetic fields to the glow from X-ray binary systems that pepper the galaxy. Finally, to reveal the dynamism of the Universe at the largest of scales, the incredible turmoil of the Antennae galaxies is dissected to reveal the shocked star-forming regions, super-heated gas and sweeping hydrogen tails.

Noreen Grice designed the tactile images and teacher Ben Wentworth and the students at the Colorado School for the Blind evaluated the prototype tactile images. The book includes a foreword by professional mountain climber Erik Weihenmayer, who describes his sense of discovery as the world's first blind person to climb Mt. Everest. Erik's frontiers widen as he climbs to new heights, just as our understanding of the Universe widens through previously unseen views.

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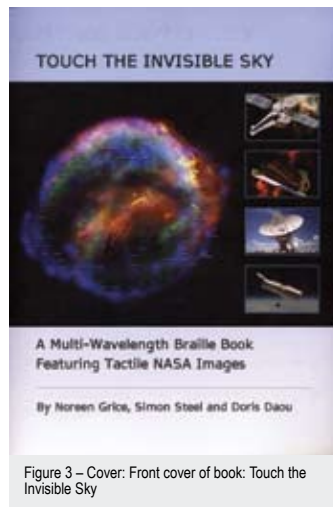


Figure 3 – Cover: Front cover of book: Touch the Invisible Sky