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THE ULTRAVIOLET UNIVERSE

FIGURE 44: ANDROMEDA IN THE ULTRAVIOLET

Approximately 2.5 million light-years away, the Andromeda Galaxy, or M31, is the Milky Way's largest galactic neighbour. The entire galaxy spans some 260 000 light-years— a distance so large that 10 images from the Galaxy Evolution Explorer stitched together were needed to produce this view of the galaxy next door. The wisps of blue making up the galaxy's spiral arms are neighbourhoods that harbour hot, young, massive stars. The central orange-white ball reveals a congregation of cooler, old stars that formed long ago. Andromeda is so bright and so close that it is one of only three galaxies that can be spotted from Earth with the naked eye. This view is a two-colour composite, where blue represents far-ultraviolet light, and yellow is near-ultraviolet light.

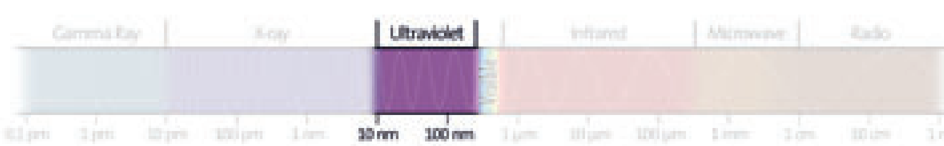
Ultraviolet light falls beyond the limits of what we can see at the blue end of the spectrum. In human terms the word ultraviolet calls to mind images of sore skin resulting from overexposure to the Sun, an indication of the high energy of this form of light.

The hottest stars in the Universe are brightest in ultraviolet light. The dusty clouds that give birth to these massive, luminous objects are in turn sculpted and shaped under the onslaught of the high energy photons they emit. Ultraviolet light shows us where the action is in star formation — amongst the young, the massive and the hot stars.

“Paradoxically, ultraviolet light drives the very processes in our atmosphere that keep much of it from reaching the ground”

Ultraviolet light largely originates in the glow of stars. The hottest and most massive stars glow brightest in the ultraviolet, but even our cooler Sun still produces a fair amount of light in this part of the **spectrum**. The ultraviolet spectrum starts just beyond blue-violet at a **wavelength** of 400 **nanometres** and includes wavelengths down to 10 nanometres at the extreme end. Remember the rule: the shorter the wavelength, the higher the energy. A single ultraviolet **photon** can carry as much energy as 50 or more photons of red light!

Ultraviolet regimes



The ultraviolet spectrum can be broken down into four **regimes** of increasing energy.

Near-ultraviolet: 400–300 nm

These wavelengths lie just beyond the limit of human vision and encompass the “black light” often used at parties to illuminate a variety of **fluorescent** materials such as white paper, paints, inks and even teeth and nails. Near-ultraviolet radiation from the Sun reaches the Earth most readily and can be observed from the ground.

Mid-ultraviolet: 300–200 nm

Increasingly filtered out by atmospheric ozone, mid-ultraviolet radiation from the Sun still reaches the ground in sufficient doses to cause sunburns and damage that can lead to skin cancer.

Far-ultraviolet: 200-122 nm

The atmosphere is essentially opaque to far-ultraviolet radiation, so space telescopes or high-flying rockets must be used to observe in this regime. This light is sufficiently destructive to kill bacteria easily and so can be used to sterilise objects. It also poses the greatest threat to the spread of life by panspermia — the transport of organisms through space on and near the surface of rocks that may eventually land on a planet as a meteorite.

Extreme-ultraviolet: 122–10 nm

This most energetic band of ultraviolet extends to the border of the X-ray spectrum. Extreme-ultraviolet emission is usually associated with the very hottest stars in the Universe.

On Earth we are sheltered from much of the Sun's ultraviolet as the ozone in our upper atmosphere filters out a great deal of the Sun's shorter wavelength ultraviolet. Significant absorption begins beyond around 300 nm, making ground-based observations very difficult at anything other than near-ultraviolet wavelengths. While a bane to astronomers, this makes exposure to sunlight much safer for us. Ultraviolet photons carry much more energy than visible photons, enough to do damage to our skin and even the DNA in our cells.

Paradoxically, ultraviolet light drives the very processes in our atmosphere that keep much of it from reaching the ground. Ozone, which is the primary filter against the more harmful forms of ultraviolet, is actually produced in the upper atmosphere when incoming ultraviolet photons interact with oxygen molecules.

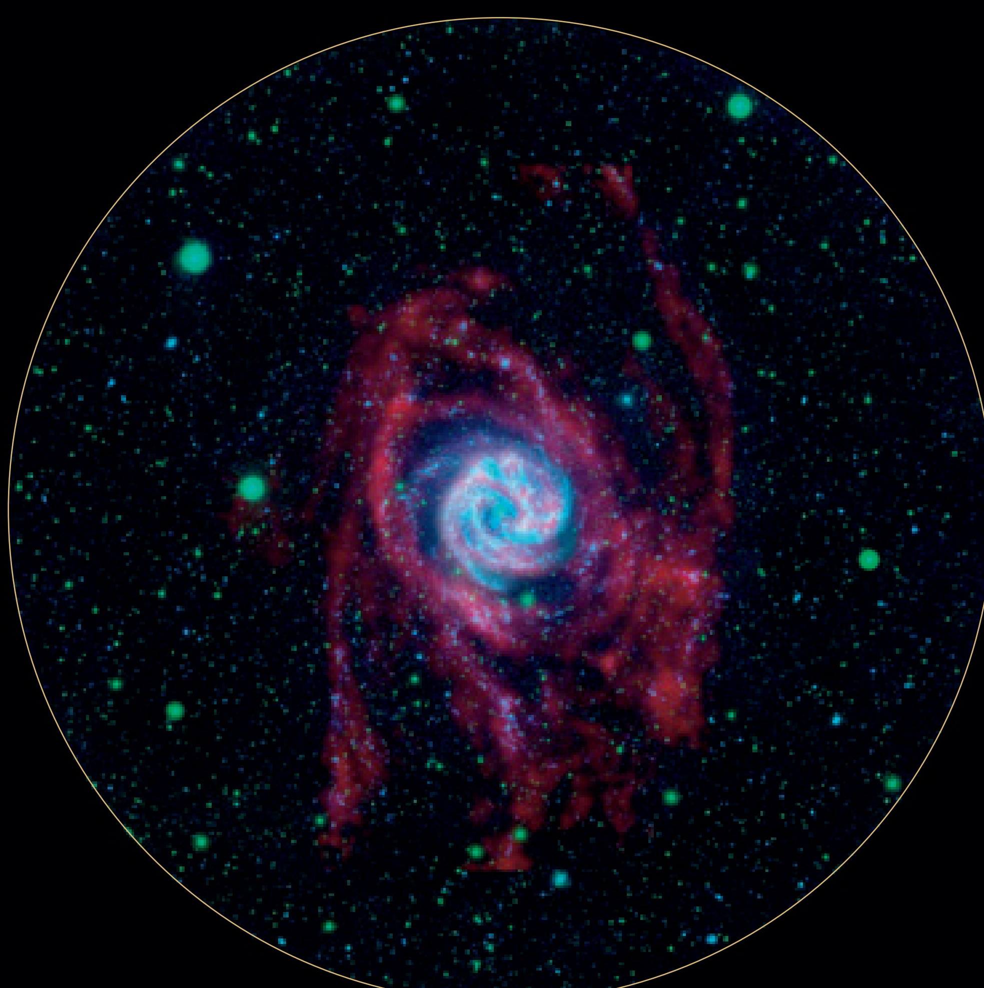


FIGURE 45: WHAT LIES BEYOND THE EDGE OF A GALAXY?

This deep ultraviolet view of the Southern Pinwheel Galaxy M83 has revealed an unexpected surprise. Beyond the well-known visible disc of this classic spiral are faint but clear ultraviolet arms (rendered here in blue and green) far out beyond any that had been seen before. But these loosely wound arms of hot young stars are not alone in the outer reaches. Radio imaging of the hydrogen gas (shown in red: see Chapter 7) in this galaxy shows extended gas arms that line up perfectly with the ultraviolet arms. There is an entire cycle of star formation going on far beyond what was once considered to be the disc of the galaxy!