Portrait of a Galaxy

Our sun and its retinue of planets drift in the backwaters of our Galaxy—we all know this, if not from astronomy class, then from the T-shirts and posters of the Milky Way with an arrow pointing at a speck on the edge of a spiral arm, accompanied by the caption "We are here." This playful depiction conveys our place in the Milky Way. But missing is a sense of its turbulent history, from its youth, when it grew by merging with neighboring galaxies, through its present-day shredding of a nearby dwarf galaxy. Nor will the picture mean much in several billion years, when the Milky Way is expected to slam into the Andromeda galaxy and give birth to a new supergalaxy. This special issue highlights the extensive observations and thought-provoking models of how our Galaxy formed and evolved, the objects that populate it today, and its fate.

The first Review article, by Buser (p. 69), describes the latest thinking on the Milky Way's structure, a spiral cocooned in a spherical halo of dark matter and a smaller halo of stars. When the spiral arms are viewed edge-on, the Galaxy's nested structure comes to light: Moving from the outside in, one first encounters a thick disk of stars and gas that orbit the Galactic center in slow, sweeping orbits. Inside this disk is a thinner one with faster components in tighter orbits, giving a flatter structure. Finally, tucked inside this thin disk is the so-called extreme disk, with what may be a central barlike bulge, composed of rapidly moving stars and gas clouds. This composition suggests that the Milky Way formed over 12 billion years ago, building up with each successive merger from a simple thin disk to the complex spiral seen today. Complementing this discussion, Irion starts the News section with a panoramic look at mergers in the Milky Way's lifetime (p. 62).

Just as compelling is what we can't see in the Milky Way. Alcock (p. 74) reviews what's known about the invisible dark halo: the largest component of the Galaxy, containing about 95% of its mass, that some theorists suggest is populated by ancient dwarf stars and exotic elementary particles. Clues to the nature and extent of the dark halo come mostly from how the motions of stars and nearby galaxies are perturbed by the dark matter. Scientists had hoped that observations of rare microlensing events, when dark objects bend light from distant stars, would solve the riddle of dark matter. But as Schilling discusses in a News story on p. 67, microlensing has shed more light on other facets of our Galaxy.

Moving inward from the dark halo, Bland-Hawthorn and Freeman (p. 79) review what we can see in the stellar halo, which makes up only 0.2% of the Galaxy's mass. This faint, diffuse halo is composed of ancient stars and globular clusters. Finally, Yusef-Zadeh, Melia, and Wardle (p. 85) describe what's known about the heart of the Milky Way. The Galactic center contains what appears to be a supermassive black hole. In a News story (p. 65), Stokstad tells how scientists can now make a stronger case for this giant based on measurements of stars caught in its gravitational embrace. Surrounding the black hole is a cluster of older stars, a remnant of what may have been a supernova, and a mix of young stars and gaseous clouds. Understanding how these components interact will improve models of other galactic nuclei thought to be powered by black holes of their own.

From its humble beginnings to its present complexity and future transformation, the Milky Way, as seen from our quiet corner, is coming into ever-sharper focus. The emerging story is still wrapped in mysteries, but it is teaching us more about our home Galaxy, the formation of other galaxies, and ultimately, the evolution of the universe. **–LINDA ROWAN AND RICHARD STONE**

CONTENTS

Science