Tucked under the Handle of the Big Dipper is a fascinating double galaxy that's a favorite target of backyard astronomers.

The Whirlpool Galaxy

by KEN HEWITT-WHITE

LOOK UP. LOOK WAY UP. A telescopic treasure awaits you almost directly overhead these late-spring nights. It's the Whirlpool Galaxy, one of the finest spiral galaxies in the entire sky. Like our own Milky Way, the Whirlpool is a slowly turning, disk-shaped star system comprising billions of suns bound together by gravity.

The Whirlpool Galaxy's signature spiral structure dominates the photograph on the facing page. Many gaseous nebulas and thick lanes of dust are concentrated in the arms that coil around the central bulge. A second, much smaller galaxy is visible near the top of the photo. Are they connected? I'll let you know later.

Being a galaxy in its own right, the Whirlpool lies outside our own Milky Way Galaxy. How far outside? Try 27 million light-years. (A light-year is the distance light travels in one year, roughly 6 trillion miles.) Today we know that countless galaxies populate the universe at distances vastly greater than that of the Whirlpool. However, until about 80 years ago astronomers had no solid proof that anything existed beyond the Milky Way.

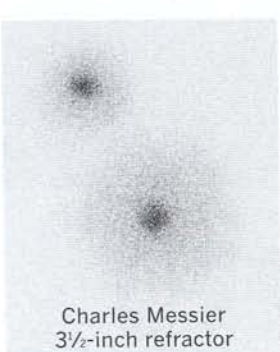
French comet hunter Charles Messier discovered the Whirlpool Galaxy on October 13, 1773. Like many of his other finds, it looked like a comet but didn't move like one — instead, it stayed at the same spot with respect to the stars. He published a list of these impostors so that other observers would not mistake them for comets.

At first glance, most of Messier's objects looked like clouds of light, or nebulas, but when he examined them carefully, some of them resolved into clusters of stars. The 51st entry in his catalog was particularly odd. Messier wrote, "It is double: both parts have bright centers. The two atmospheres are in contact; one is much fainter than the other." Where did Messier 51 (or M51, for short) fit into the cosmic scheme of things?

English astronomer John Herschel had a hunch. In 1830 he studied M51 using a telescope with an 18-inch-wide mirror — one of the largest in the world at that time. He saw the main nebula as "a very bright, round nucleus surrounded . . . by a luminous ring." That observation set Herschel's mind afire, for the "luminous ring" reminded him of the band of the Milky Way arching across the night sky. Speculating that M51 might be another galaxy, he wrote, "Supposing it to consist of stars . . . can it then be that we have here a brother system, bearing a real physical resemblance and strong analogy of structure to our own?"

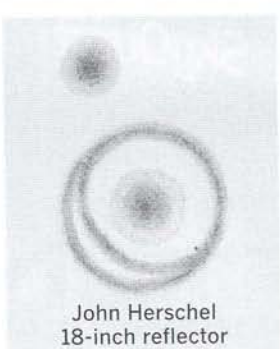
Herschel's tantalizing question was embraced by the Irish nobleman William Parsons, the third Earl of Rosse. In 1845

Improvements in telescopes have revealed increasing detail in M51. Messier himself left no sketch of this galaxy; the one at lower left is based on his description and on modern observations with similar-size instruments.

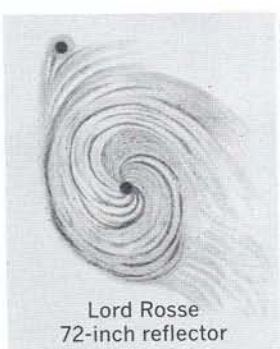


Charles Messier
3½-inch refractor

TONY FLANDERS



John Herschel
18-inch reflector



Lord Rosse
72-inch reflector

HANDBOOK OF ASTRONOMY, 4TH ED., G. F. CHAMBERS (2)

The strikingly symmetrical form of the spiral galaxy Messier 51 is distorted by the presence of a small companion galaxy called NGC 5195. One lanky arm of the Whirlpool seems to be reaching out to ensnare NGC 5195, but the cosmic embrace is an illusion. The sideswiping spirals parted company some 280 million years ago.

Lord Rosse finished construction of a 72-inch reflector — by far the largest telescope then in use. With this massive instrument he discovered spiral structure in M51. Rosse failed to resolve the cloudy coils into individual stars, but his observations stirred the debate about M51 and the other "spiral nebulas" that he found. Ironically, spiral structure would later be used by some scientists as an argument that these misty pinwheels were not galaxies of stars but whirlpools of condensed gas within our own galaxy on their way to forming solar systems.

The controversy raged for decades. The true nature of spiral nebulas wasn't fully established until the 1920s when American astronomer Edwin Hubble began working with the new 100-inch reflector at Mount Wilson Observatory in California. Hubble employed photographic techniques to measure the distances to stars embedded in some of the objects — stars that couldn't be seen at all in lesser instruments. His results proved that the host "nebulas," including M51, are galaxies well outside the Milky Way.

nebula or galaxy?

A *nebula* is a cloud of glowing gas. A *galaxy* is a huge collection of stars and nebulas. Galaxies are so far away that the individual stars blend together, so galaxies *look* like glowing clouds even though they're not.

The Hubble Space Telescope's view of M51's center shows dark streaks pointing at sharp angles to the main spiral arms. These may be remnants of a spiral pattern that predated M51's encounter with NGC 5195.

Fatal Attraction

M51 is also known as NGC 5194 from its listing in the *New General Catalogue*, a compendium of some 8,000 deep-sky objects published in 1888. The Whirlpool's irregular companion is NGC 5195, and, as mentioned earlier, the two seem to be attached. However, if you inspect the photo on page 31, you'll find that M51's lanky spiral arm that reaches across the intervening void is silhouetted against its neighbor galaxy. NGC 5195 therefore must lie somewhat behind M51, though astronomers aren't certain by how much.

What astronomers do know from careful telescopic measurements is that the two galaxies are moving apart at more than 300,000 miles per hour — and thus that they were once much closer to each other. In fact, long ago they experienced a slow-motion sideswipe that took millions of years to play out. Computer simulations show that during the altercation their gravitational fields would have become entwined, leading to dramatic changes in both galaxies.

This close encounter raises intriguing questions about the Whirlpool's origin. One hypothesis suggests that M51's spiral form was created when NGC 5195 brushed past it. A contrary view asserts that the arms existed prior to the galaxies' interplay. The latest thinking merges these ideas. Perhaps M51 originally possessed a more compact spiral structure. As NGC 5195 slipped by, its gravity extracted opposing filaments of stars from the big galaxy. M51 then slowly wound its new limbs into the extended spiral arms we see today. The hapless companion fared worse, for it's been stripped of any arms it may once have had.

Recently, a team led by astronomer Patrick Durrell (then at Pennsylvania State University) measured the motions of three dozen planetary nebulas all around M51. (A *planetary nebula* is a shroud of gas thrown off by a dying star.) These observations revealed that the nebulas fall into two distinct groups, one related to each galaxy. Knowing this, Durrell and his collaborators refined their computer simulation and concluded that the galaxies grazed each other only once, some 280 million years ago, and likely won't interact again. Not all astronomers agree with this conclusion, however. Understanding the origin and fate of the Whirlpool is still very much a work in progress.

300 million years ago

150 million years ago

Today

Patrick Durrell and four colleagues at Pennsylvania State University created this computer simulation of the encounter between M51 and its smaller companion, NGC 5195.

Viewing the Whirlpool

Want to locate M51 with your telescope? You shouldn't have much trouble if you use the charts on page 34. But make sure you pick a clear night when the Moon isn't lighting up the sky, and wait for at least 20 minutes to become dark adapted before peering into the eyepiece. Don't expect a dazzling view — especially if you're observing from a suburban backyard with a fair amount of light pollution. M51 is relatively bright for a galaxy, but it's small and faint compared to the best-known nebulas and clusters in the Milky Way.

Discerning the spiral arms is difficult because they're submerged in M51's dim, diffuse halo. Observing with a 4.5-inch reflector in my backyard (I live in a town of 60,000 people), I see only side-by-side fuzzballs — the tiny cores of both galaxies. You'll do better if you have a bigger scope or fewer lights. Using a small scope at a dark site, you may duplicate

Messier's observation of two bright cores enveloped by ghostly halos that just touch each other.

If you can see the faint outer sections of the galaxies, look for one or two brighter patches — a tantalizing hint of spiral structure — within them. Detecting these subtle features requires the right amount of magnification. Use too little and the galaxy won't appear large enough to show detail. Using too much will spread out the pallid halo, rendering it invisible. Magnifications around 50× to 125× work well with telescopes whose apertures (main mirrors or lenses) are 3 to 6 inches wide. And try "averted vision," looking slightly to one side of the galaxy.

What about larger optics? My colleague David Rodger observes with a 9¼-inch telescope in a city of 1 million people. On the best nights David describes M51's halo as "a complex, irregular glow," an indication that the spiral arms are almost within his grasp. I get a similar result at home with my 10-inch reflector. Magnifying the galaxy between 150× and 200×, I can tease out a pair of faint, fuzzy arcs — short segments of the arms. For serious viewing I pack up the scope and drive to a remote observing site. There, well away from the glare of city lights, the Whirlpool's delicate spirals finally materialize in the 10-inch scope.

Admittedly, coaxing these arms into view can be tough. If, to your eye, M51 seems more wisp than whirlpool, consider that you're witnessing something so distant that light itself — the fastest thing there is — takes 27 million years to travel from the galaxy to Earth. The feeble image reaching your eye is made of photons that left M51 long before the dawn of human consciousness. The payoff with the wondrous Whirlpool is not so much what your eye detects but what your mind perceives.

Life of the Party

The arms of the Whirlpool come to life in large-aperture telescopes. In the author's 17½-inch Dobsonian reflector the pinwheel pattern glows so distinctly that it exudes a photographic quality. If you want the best possible view of M51, make plans to attend a star party (March/April, page 42). At these informal gatherings you can usually find someone who will oblige you with a view of the marvelous Whirlpool through a large telescope. You'll find the dates and locations of star parties in the U.S. and elsewhere at SkyandTelescope.com/resources/calendar.

M51 forms a right triangle with Mizar and Alkaid, the stars at the end of the Big Dipper's Handle, and it's a little more than half as far from Alkaid as Mizar is. Under clear, dark skies, you should be able to spot the galaxy as a faint smudge in 50-mm finderscopes and binoculars.

Canadian stargazer **Ken Hewitt-White** observes the Whirlpool Galaxy from various sites near his home in British Columbia.