

## Unifying principle said to govern all galaxies

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Astronomers have found a mathematical principle that they say surprisingly fits all galaxies, from the state-like spiral-shaped ones to the messy "train wrecks." This could reveal something deep about the evolution of the universe, they claim. In a new study using the W.M. Keck Observatory in Hawaii, the scientists found that this commonality has linked all galaxies for eight billion years, nearly half the age of the universe.

An image of colliding galaxies captured in 1999 using the Hubble Space Telescope. The objects are part of a large galaxy cluster designated MS1054-03. It is about eight billion light-years away, hence shows itself to us as it looked that number of years ago. (Courtesy Piet van Dokkum, Martin Franx [University of Groningen/Leiden], ESA and NASA)

All galaxies, they said, follow a consistent relationship between their mass, or weight, and the velocities of the stars and gas clouds that compose them. "We were truly surprised at how well the pattern fits a dizzying array of galaxy types," said Sandra Faber of the University of California, Santa Cruz, co-author of the study. The report is to appear in a forthcoming special issue of the research publication *Astronomical Journal Letters*. Galaxies fall into three basic types: spiral or disk-like ones such as our own Milky Way; those shaped like roundish clouds, known as elliptical galaxies; and messy, bashed-up or oddball galaxies. These are usually thought to be remnants of galaxy collisions, and sometimes dubbed "train wrecks." Astronomers noted years ago that for spirals and ellipticals, there were specific relationships between their masses and the velocities of their constituent stars. These rules are called the Tully-Fisher and the Faber-Jackson relationships, respectively. What was not known, Faber and colleagues said, was that these two relationships "which seemingly work differently" are themselves related, as aspects of one overarching rule. And this principle also applies to the "train wrecks," not previously known to respect any such law. According to Faber's group, in all galaxies, there is some orderly, regular rotation: the constituent stars and gas clouds revolve together about a common center. For train-wreck galaxies, this neat rotation is overlaid with a certain amount of mixed-up velocities. The researchers devised a new measure of the component velocities, which they called a "speed indicator." It combines both the orderly rotation velocities and the random or disordered motion. This property turns out to be strictly related to the mass of galactic components, said Susan Kassin, a postdoctoral researcher at the University and the study's lead author. "Surprisingly, if you use this new speed indicator to measure the motions of stars and gas in a galaxy, you can predict the mass in stars the galaxy has with pretty high accuracy." Galaxies like our Milky Way consist of billions of stars formed into a spiral disk along with some gas. Our galaxy also spins like a pinwheel at a few hundred kilometers (miles) per second. Such elegant galaxies were scarce once, the scientists said.

Asâ-troâ-noâ-mers can obâ-serve the anâ-cient uniâ-verse by lookâ-ing exâ-tremeâ-ly far away, beâ-cause this means the light we see left those arâ-eas bilâ-lions of years ago. Half of the age of the uniâ-verse ago, many galaxâ-ies look more diâ-shevâ-eled, as they were beâ-ing asâ-semâ-bled through galâ-axy colâ-liâ-sions and the pilâ-ing on of new gas and stars, Kassâ-inâ€™s team said. The new findings in essence show that the mixed-up and orâ-derâ-ly veâ-locâ-iâ-ties are someâ-how reâ-lated, said Ben Weiner of the Uniâ-verâ-siâ-ty of Arâ-iâ-zoâ-na in Tucâ-son, Ariz., anâ-othâ-er co-auâ-thor of the stuâ-dy. â€œThe mixed-up veâ-locâ-iâ-ties may setâ-tle down to orâ-derâ-ly roâ-taâ-tion over time as the uniâ-verse ages,â€• he proâ-posed. The findâ-ings probâ-aâ-bly reâ-flect an even deepeâ-r propeâ-rty of the cosâ-mos, said Faber, one of the nameâ-sakes of the Faber-Jackson reâ-laâ-tion, which she helped deâ-velâ-op in 1976. â€œBoth of these reâ-laâ-tions were imâ-printed by the naâ-ture of flucâ-tuâ-aâ-tions [in the uniâ-verse] that made galaxâ-ies in the first place,â€• she said. â€œThis reâ-laâ-tion holds for all the galaxâ-ies, no matâ-ter what they look like,â€• Kassâ-inâ€™ marked. â€œIt ties toâ-gether the Faber-Jackson reâ-laâ-tion with the Tully-Fisher reâ-laâ-tion and works for all kinds of oddâ-ball galaxâ-ies that are more comâ-mon in the earâ-ly uniâ-verse.â€• The study inâ-volved 544 far-off galaxâ-ies of varâ-iâ-ous types. Kassâ-inâ€™ said that makes it the largâ-est study to date of the speed and moveâ-ment of disâ-tant galaxâ-iesâ€™ stars and othâ-er matâ-ter.

Courtesy World Science

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