4 THE COLLIDING GALAXIES MOVIE

NGC 2623

Several Hubble datasets were added together to produce this deep and quite spectacular color composite of NGC 2623. The galaxy exhibits two prominent tidal tails that are 80,000 light-years long as well as a network of dust lanes. The most prominent feature in the image of NGC 2623 is a concentration of about 100 unresolved star clusters — one of the richest and most compact regions of bright star clusters known.

Having just one observing point in space, our Earth, and a very limited lifespan, we are not able to imagine fully the three-dimensional action taking place when galaxies collide, twist, and turn in space over millions of years. The sharp vision of Hubble provides us with enough snapshots of different collisions that we can piece together a movie of a full galaxy collision, frame by frame.

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Imagine you could move back and forward in time and travel great distances with a speed greatly exceeding the speed of light. Observing a galaxy collision as it unfolds from start to finish over billions of years from all angles would give you a stunning view of phenomena that no one has ever seen in reality. This is naturally an impossible dream, but we can go part of the way by using supercomputers to simulate a collision using real physics. The visualization of a galaxy collision shown to the left in the panels on the following three pages is created from one single supercomputer simulation and shows the entire collision as a movie sequence from different angles. As we cannot observe the same collision over the necessary time scale we compare the simulation with *different* interacting galaxy pairs observed by Hubble. It is a bit like trying to reconstruct the cultural connections of people on Earth from just one snapshot of each city. Not an easy task, but even so the correspondence between the simulations and the pictures is stunning. This comparison of research simulations with high resolution observations allows astronomers to understand these titanic crashes better. It is clear that much of the diversity of observed galaxy collisions is due in part to the varying angles we observe them from and the different times in their lives at which we observe them.

The sequence starts with two distinct individual undisturbed spiral galaxies of roughly the same size. Gradually the two main bodies attract each other, creating shock waves that increase the process of star formation. Long tails of stars and gas are flung out by the tidal forces. Slowly the remaining structures of the galaxies are smoothed out, as the tidal tails are either lost in the surrounding space or finally rain back onto the new galaxy created in the merging. For a while longer the two supermassive black holes persist as the only testimony of the past of the combined galaxy that by now has lost its spiral patterns and structurally looks more and more like an elliptical galaxy.

Naturally the detail of a galaxy collision plays out differently depending on how evenly matched the contenders are in mass, on the approach speed, and angle compared to the spin axes of the involved galaxies. There are plenty of odd-looking systems, such as polar-ring galaxies, where the debris settles into rings over the pole of the large galaxy for a while (see page 76).