CHAPTER TWENTY FIVE

Crash go the galaxies

DOES A FISH GIVE THOUGHT TO water? Does a bird give thought to aero dynamic forces? Are we any more inclined to give thought to gravity? Yet that's what enables us to sleep soundly at night without fear of drifting spaceward. (Though as children we were not so sure of a positive outcome each morning—remember those dreams of free-falling through space?) It's what makes our feet invariably touch down on solid ground after every single step. Of course we don't give it a moment's thought because we are surrounded by it, held in its embrace, and are oh so familiar with it. It's always there doing its stuff. And it does its job perfectly without any thought on our part.

We are so familiar with gravity we fail to appreciate the marvels it performs. We are dazzled by laser light displays. We stand spellbound before the rapidly-changing shafts and fans of delicate auroras. We chuckle with delight watching monkeys toss and tumble. We are mesmerised by the beauty of a displaying peacock. We stand in awe of huge waves rolling in from the open ocean and smashing against steep seaside cliffs. But when gravity performs unwelcome tricks, perhaps leading to a grazed knee when it takes us unawares, we complain bitterly.

Generally, we are not impressed by gravity. If only we had the eyes to see and the heart to heed, we could be entertained indefinitely by the universal puppet show directed by God and controlled by gravity's strings. Gravity does some neat things. You see, galaxies, like football players, can collide, and when they do, the results are hugely entertaining. Galaxies, however, are not brought into close contact by the attraction of a ball, but by the pull of the universal invisible force of gravity.

What happens when galaxies stray too close to each other? Do bigger ones gobble up little ones, sating their colossal galactic appetite? Or do they explode, or set each other on fire? Or might they pass through each other virtually unscathed? Or do they tear each other apart? Answer: all of the above. Read on as we peer out through the telescope at the fascinating world of crashing galaxies. And as we do so, let's make the connection with Jesus Christ, the one who made it all happen.

Predicting the outcome

Genius is not required to predict that interesting interactions could occur. When you realise that galaxies are hurtling through space within their host clusters in all directions, it stands to reason that some are going to cross paths in time. And they do. Predicting exactly what will happen is, well, a whole lot more complicated. The concept that they will react in different ways depending on angle of attack, relative masses, and so forth, is also simple to grasp. But the possible variations on the one simple theme are so endless that predicting precisely what will happen all across the spectrum of possibilities becomes very complicated.

Fortunately, we have numerous case histories to look at and learn from. But, even with hindsight, many mysteries remain. Many galaxies boast peculiar features that presumably were wrought in the crucible of some kind of collision, but, even after the

event, experts can't be certain what happened.

For example, the outer spindly arms of Galaxy M33 are bent away from and out of the flat plane of the galaxy, a most unusual occurrence. Yet no galaxies seem to be near enough to have produced that effect through recent gravitational interaction (Ferris 1982, p. 72). Experts suggest that possibly this galaxy has, at some time in her history, taken a massive cloud of intergalactic gas and dust as her dance partner, only to discover that her partner had a seamy side, tugging lewdly at her skirts. This possibility introduces yet another variation on the theme of collisions—that galaxies can interact not only with other galaxies, but with great balls of gas. Can you imagine it?

Another explanation is possible for the bizarre warping of M33. Maybe she was created that way 'in the beginning'. Either possibility is rational; which one you personally plump for depends on your philosophy of universal creation. Either way, God gets the glory.

Close encounters of the galactic kind

What set some galaxies on a collision course in the first place? That's hard to say. But however it has happened, compelling evi-

M101, a giant spiral galaxy in Ursa Major. Note the asymmetrical pattern of the arms which is brought about, astronomers believe, by gravitational interaction with nearby galaxies.

dence suggests that untold numbers of galaxies either are now interacting, or have in the past interacted gravitationally with neighbouring galaxies. The numerous variations on the one theme reflect yet again the infinite capacity for lateral thinking by the Paramount Thinker.

We noted in a previous chapter that galaxies are invariably found permanently clumped together in clusters, their mutual gravitational effects yoking them invisibly, making them behave as a team, like harnessed horses. But often two or more galaxies nudge closer and closer to each other yielding some amazing results.

Note the way Timothy Ferris (1982, p. 122) describes the concept of interaction:

> Normally each major galaxy is free to reign within a comfortable volume of space, its neighbouring large galaxies keeping their distance. Sovereignty is violated when a neighbouring galaxy drifts close enough that its gravitational dominion begins to interfere with domestic order.

By the way, there is no law which limits interactions to two galaxies only. In *Stephan's Quintet*, a group of four galaxies (one, remember, only appears to be part of the group) is clearly in mutual turmoil. Some observers believe that in time they will merge into a single galaxy.

Snapshots in time

Variation is added to the collision theme by the relative sizes, velocities, and direction of motion and rotation of the players, just as in football the results of a collision vary dramatically depending on the relative bulk of the opponents, and the manner in which they collide. There is one major difference between interactions between footballers and interactions between galaxies—in football, it's all over in a flash, unless the players decide to turn it into a brawl. With galaxies, the period of mutual meddling can last up to 500 million years (*Astronomy* Jun. 1985, p. 60)!

Obviously, when you consider the size of galaxies, it would take many generations of photo-snapping for any movements to be detectable. When we train a telescope onto two galaxies in full, head-on collision, with stars streaming past each other in opposite directions, all we are seeing is one frame in a sequence containing many thousands of frames—a snapshot of endless time. A photo taken ten thousand years from now would look almost identical. We cannot see the rapid movements. Such apparent tranquillity belies the massive upheavals taking place.

How can we know, then, that such interactions occur? Astronomers agreed only recently—in the decade of the 1980's—that such interactions do occur (*Scientific American* Aug. 1991, p. 26).

A number of factors lead to this conclusion. First, because many thousands of such interactions are in progress at any moment, astronomers can take a whole series of snapshots of different interactions, and intelligently piece together a collage. Second, many galaxies (though only a small percentage) are so weird in shape that, unless one accepts the notion of their being created in that condition, only violent interplay that tears and shreds the galaxies can possibly explain their freakish features. Finally, we can sometimes hear their screams, often in the form of powerful radio pulses emanating from the disturbed hearts of the crash victims or, alternatively, from huge doses of infra-red radiation that some encounters cause.

Kinds of interaction

Yes, like collisions between football players, no two galactic bumps, or near misses, are the same. And the array of effects beggars description. As Timothy Ferris (1982) puts it, using a rather different metaphor to the football one, 'The dance of interacting galaxies can be as stately as a minuet or as frantic as a mazurka'.

One aside needs noting before we move on. We might expect such galactic manoeuvres to result in starcrashes. However, that rarely happens, if ever. The stars in a galaxy are so far apart compared with their diameters that a galaxy is nearly empty, as far as stars are concerned. The collision of two galaxies is not likely to involve a single collision of two stars (Hodge 1986, p. 144). The chance of a collision between two stars is roughly the same as the chance of a collision between two houseflies flying in opposite directions through the Grand Canyon.

So what sort of things happen when two or more galaxies decide to dance? In a word, *bizarre* things. For the sake of simplicity, we can categorise the interactions into three groups—collisions, mergers and ships in the night.

A *collision* occurs when two galaxies pass through each other *and* come out of it

in two pieces, each one continuing on its own merry way after the accident, bruised and beaten, but otherwise intact. The footballer and dancer metaphors break down, as they (believe it or not) never pass right through each other. When the velocities and sizes of two galaxies are such that they coast to a halt and fall together, staying happily wedded ever after, they are said to *merge*. If one of the two galaxies is considerably larger than the other in a merger, then the event is often described as an act of cannibalism, with the bully grinding up its victims into building blocks for its own growth. Galaxies act like *ships in the night* when they pass near enough to each other to feel the effects of the other's wake, but do not actually mingle their tissues.

Explaining why some galaxies collide and pass on, while others merge and mix their tissues forever, is not easy. The difference stems from a complex interplay of relative sizes, velocities and distribution of mass. Two galaxies that might pass right through each other at high velocities would probably merge if the velocities were considerably lower. The angle of attack may have some influence too, though minor compared with other factors. The dynamics of galaxy interplay are under close study by many workers, and over time all sorts of fascinating stories will undoubtedly emerge. Computer simulations have helped investigators understand better the remarkable dance steps that some interacting galaxies perform. When astronomers studied one interacting pair, they found them to be in the process of performing a do-si-do, with the two galaxies turning sharply around their common centre of gravity and parting a hundred million years later (Ferris 1982, p. 120).

Effects of collisions

In one kind of head-on collision, a smaller galaxy can 'punch a hole' in a larger galaxy as it hurtles through it. The central mass of stars of the 'receiving' galaxy remains pretty much intact. But as the interloper races through (taking millions of years to do so), stars in the disk of the victim galaxy are drawn towards the centre because of the increased gravity produced by the mass of invading stars. Later, when the invader has passed on its merry way, the gravitational pull towards the centre drops dramatically, and the inward moving stars recoil, and ripple back outwards. The effect is to produce a galaxy that looks, for a while, like a central ball surrounded by a wispy ring of stars. Eventually, and don't ask me to explain how, the galaxy returns to its original form.

On the other hand, when galaxies approach each other at very high velocities—thousands of kilometres per second—they can pass right through each other suffering almost no damage through the encounter (Scientific American Aug. 1991, p. 26). The slower an encounter between two galaxies, the more time there is for gravity to produce serious damage

When galaxies slice right through each other, one inevitable result is the collision of enormous clouds of gas and dust in the two galaxies. Such collisions result in awesome shock waves that are attributed with the power to initiate bursts of star formation in the affected clouds.

Effects of 'ships in the night'

Gravitational tugs-of-war between galaxies can work wonders on galactic nuclei, 'turning them on' so to speak, stoking their fires to an unprecedented level of activity. As two galaxies slide closer together, their gravity can disrupt gas clouds that previously had been in stable orbits around each galaxy's central bulge, leading to collisions of clouds which in turn initiate a complex process of streaming of the clouds into the core of the galaxy. There, a drowsing monster such as a black hole feeds voraciously on the infalling gas (*Astronomy* Jun. 1985, p. 60), creating a maelstrom of highly energetic activity.

Other effects that passing galaxies have on each other depend critically on the details of the encounter. Possible outcomes include ignition of starbursts (rapid star formation), loss of material from the galaxies' outer regions, transfer of material from one galaxy to another, the sweeping away of gas and dust, and a whole treasure chest of possible bizarre distortions, including shredding and stretching of the arms in spiral galaxies.

Heavenly seasides

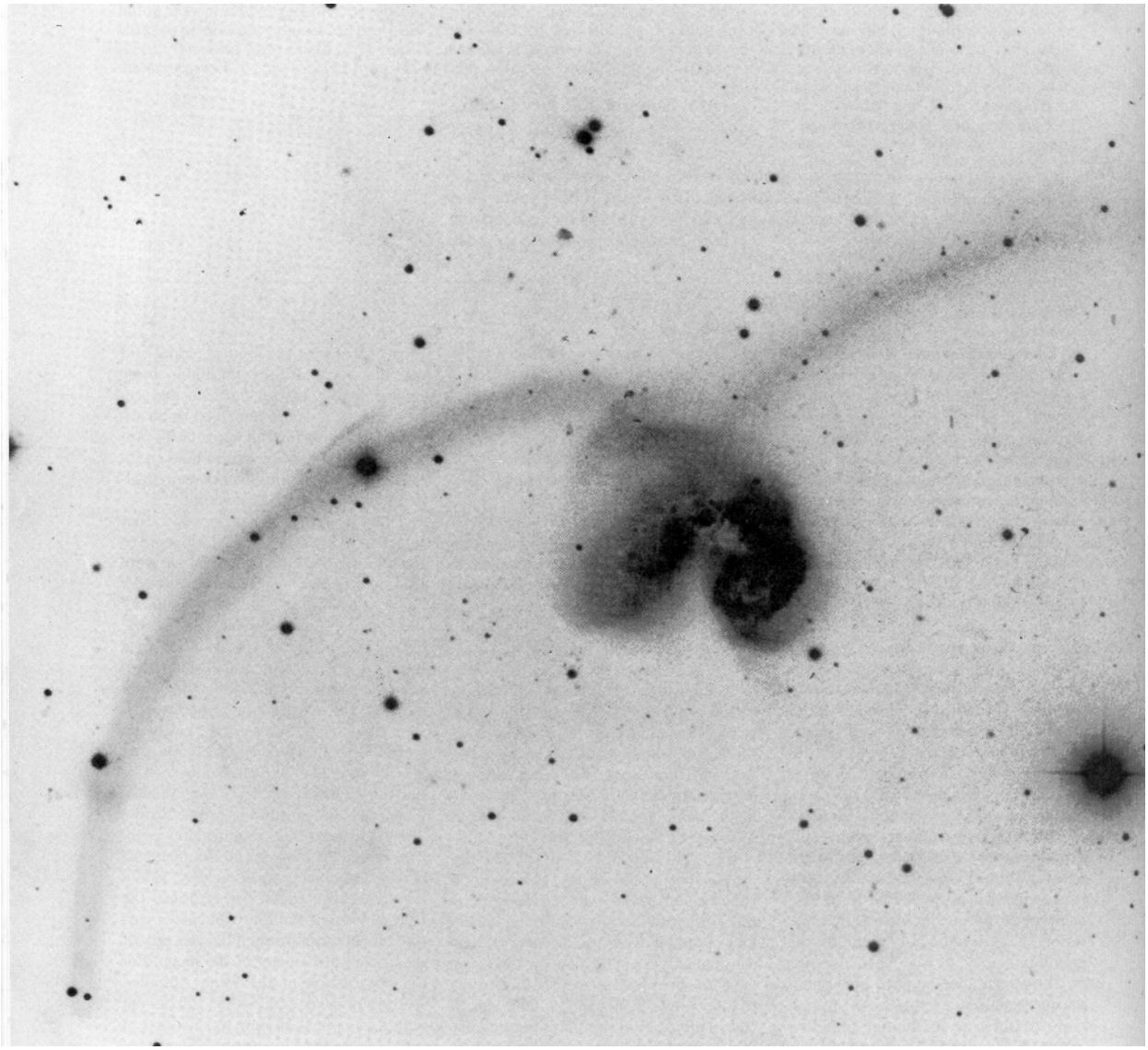
What is the magic wand producing these amazing effects when galaxies float past each other? Tidal forces. Yes, you read that correctly. As galaxies pass within about 8 to 10 galactic diameters of each other, they exert a tidal force on each other. Though the forces are weak, they operate over hundreds of millions of years, growing stronger as the galaxies draw closer. Calling on tidal forces

to explain why some galaxies have some really weird features fell out of favour for quite a while, but computer models in the early 1970's eventually won the day (*Scientific American* Feb. 1973 p. 39).

Tidal forces between galaxies are the same as those that operate on the world's oceans. Ocean tides happen because the side of the earth nearer the moon feels a stronger gravitational attraction than does the earth overall, whereas the ocean waters on the opposite side, further from the moon, experience a weaker attraction. Putting it simply, the waters on the near side are pulled towards the moon, while those on the far side draw away.

When galaxies draw close to each other, the force of gravity on the nearer sides of the double-galaxy system is much stronger than on the farthest sides. This difference begins to tear the galaxies apart, giving birth to monsters, the exact natures of which depend on the details of the rendezvous.

For instance, when passing galaxies almost collide, the result will often be what is called *rat-tail* galaxies. As they pass close by, their nearer sides unravel, sending billions of stars wafting off into intergalactic space. These stars are not the ones that form the tails. But as they float off, the galaxies lose mass. Because of this loss of mass on one side of the galaxy, the stars on the other side are not so strongly pulled inwards, and thus start to trail off into the void, like stragglers on a hike getting stretched out further and further behind the main body. What an observer sees is two mouse-like bodies—the central bulges of the galaxies—with a long



Long, faint filaments curve away from the pair of galaxies NGC 4038 and NGC 4039, also known as the Antennae.

thin tail trailing out behind each one. The best known example of this kind of interaction is called *The Antennae* by astronomers, because from earth it looks like an insect's head with two antennae poking out. The amount of dark matter within a galaxy's halo has a big influence on the nature of the rat's tail. Heavier halos produce stubbier tails (*Scientific American Quarterly* Spring 1998, p. 110).

The future of our galaxy

Our own Milky Way galaxy is hurtling towards neighbouring Andromeda galaxy at a brisk clip of 130 kilometres per second. Computer models suggest that, should they collide, we will lose. The Milky Way will merge into Andromeda. Within four billion years the galactic pair will be one spheroidal galaxy ((*Scientific American Quarterly* Spring 1998, p. 109). Won't it be fun watching that happen?

In fact, we may right now be in the process of passing as ships in the night with the neighbouring Magellanic Clouds galaxies, as they appear to be moving through our extended halo of dark matter. Who can say what effect that is having upon us right now?

Circus, zoo, or what?

To what shall we liken this engaging potpourri, this amazing agglomeration, this mind-stunning diversity, of interacting mini-universes? Is it a zoo, where caged galaxies fight with their fellow captives in frustration? Or perhaps a circus where red-nosed clowns clumsily collide because of ambulatory incompetence? Or maybe a jungle, where the strong in tooth and claw prey upon the weak, consuming them heartlessly?

Anti-supernaturalists would undoubtedly find any of the above metaphors useful to their outlook of matters universal. Or they might propose yet another—that such interactions suggest errant children guilty of unruly and sometimes selfish behaviour, all highly incongruous with the notion of a well-behaved Creator who would people the heavens with only polite, Christian galaxies. Ah, but then they are guilty of an age-old human tendency—to sculpt an image of God that they feel comfortable with. When the real God acts contrary to their image, they deny His existence.

We'll use a different metaphor. That of the celestial symphony.

A heavenly symphony

What could Gustav Holst compose if he were alive today? His orchestral suite, The Planets, cheers the spirits of flagging souls. He knew nothing of galaxies, let alone the amazing phenomenon of clashing, crashing, smashing galaxies. If only he did.

If the seething, restless movements of heavenly bodies resemble a beautiful and intricate universal symphony with an all-wise Creator as both its composer and conductor, colliding galaxies must surely provide the percussion part. Far from reflecting chaos and lack of control over God's handiworks, colliding galaxies are as beautiful and integral a part of creation as clashing cymbals are of a Berlioz masterpiece. They certainly make our universe a far more interesting place to inhabit.

Postscript

In January, 1998, NASA scientists announced the discovery of another kind of heavenly collision, this time of two entire clusters of galaxies. Studies of the cluster Abell 754 have shown that it is not one cluster at all, but two clusters in the process of merging (*Sky and Telescope* Jan. 1998, p. unknown). Computer models predict they will not come out of the collision as two separate clusters; they will merge seamlessly. Whereas collisions between galaxies can take half a billion years to complete, this collision of clusters will take five billion years. When complete, there will be no hint whatsoever of the original duo. What will God think of next?