In this issue

Birth of a paradigm

For many years now, astronomers have known of objects whose energy output can best be explained by the release of the gravitational potential energy of matter falling into a black hole. In the standard picture, gas gradually spirals in under its own internal friction, with enough time available to radiate away the heat generated. However, in the last few years, a new phrase has entered the literature 'advection-dominated accretion'. Espoused strongly by the Harvard group led by Ramesh Narayan, this alternative highlights a parameter regime in which there is not enough time to radiate away the heat generated. The energy is carried in – 'advected' – past the event horizon of the black hole. The article 'Black hole event horizons and advection-dominated accretion' by Michael R. Garcia, brings the basic observations and theoretical modelling to *Current Science* readers (**page 242**). Apart from detailed modelling of X-ray novae, a specific class of objects, there are interesting general arguments as to the *necessity* of event horizons in any viable model of the observations and herein lies the broader appeal of this body of work.

While there had been earlier hints that advection could be important in accretion phenomena, the recent work has thrust the phenomenon into the forefront, insiders know that the calculations involve cutting more than one Gordian knot – general relativity, transonic flows . . . . to get at the answer, and much work is already underway addressing these issues.

Rajaram Nityananda

Thick styles help honey bees

Every child knows the story of an intelligent thirsty crow that drank from a huge pot containing very little water. The crow raised the water level by dropping stones into it and quenched its thirst. Belavadi and his group report (**page 287**) a similar 'story' where honey bees harvest nectar from the corolla tubes of cardamom flowers from levels they cannot generally reach. But there are differences; unlike in the crow's story, the trick lies not with the ingenuity of the honey bee but with the strategy adopted by the plant. Cardamom flowers are pollinated by honey bees and in return the plant offers nectar in their long corolla tubes. Belavadi *et al.* observed that honey bees, though have a very short proboscis, could harvest nectar from much deeper levels of the corolla tube. They argue that the presence of style in the corolla tube reduces the effective diameter of the cavity of the corolla, creating a capillary effect. Consequently, the nectar level rises in the corolla tube by adhesive and cohesive forces. This rise is not purely due to the physical displacement of nectar by the style but due to additional physical forces created by the reduced diameter of the corolla tube. This helps honey bees to harvest more nectar than otherwise available to them, such that their visits to the plant are sustained. Belavadi *et al.* also demonstrate this with very simple but elegant experiments in the lab. They offered nectar to the honey bees in artificial corolla tubes containing artificial styles and showed that, in conformity with the predictions, the depth to which the nectar is harvested increases with the diameter of the style. There are problems however.

First, even if the style helps raising the nectar level, the honey bees cannot access nectar at levels lower than that their proboscis could reach. Therefore the level to which the nectar is harvested should still correspond to the length of the proboscis. But Belavadi's group found that the nectar levels in the harvested flowers were much below the length of the proboscis. They suggest that this might be possible due to the stomodeal pumps the honey bees use to 'suck' the nectar which might also help the column of the nectar to rise because of the 'stickiness' of the nectar. It is also likely that the proboscis of the bees also might reduce the effective diameter of the corolla such that when the proboscis is taken out, the nectar level falls below that the bee can reach.

Second, there are also problems in viewing this as an adaptive strategy of the plant. The functional advantage to the plant need not arise as a result of natural selection operating on the system but purely as a spin-off of the basic design of the floral whorls of the angiosperms. Fortunately, the system reported by Belavadi's group constitutes an interesting and amenable material for dissecting out these alternatives. These and other related issues are discussed in the context of the Panglossian paradigm in another article in this issue (**page 225**).

K. N. Ganeshaiah

Mathematics and nature

The fact that mathematics is useful is almost universally accepted. The realization that mathematics can be useful and applied in diverse disciplines sometimes makes 'pure mathematicians' uncomfortable. There is, after all, a perceived virtue in being untouched by other fields. In the scientific caste system, informally practised in the best of our institutions, pure mathematicians appear more glamorous than their 'applied' counterparts. But in recent times, even the most esoteric of fields can hardly remain free of some derived utility. Theoretical physicists contemplating the secrets of the universe are closer to philosophy and religion than scientists with their feet (and ideas) rooted to the ground. In constructing grand theories in physics mathematical elegance and consistency are key features. Mukunda (**page 247**) in an essay, rich in quotations from a galaxy of scientific immortals, considers the issue of 'existence and reality in mathematics and natural sciences'. For many readers, Eugene Wigner's statement that '... the enormous usefulness of mathematics in the natural sciences is something bordering on the mysterious and ... there is no rational explanation for it', will strike a chord. In attempting to define the relationships between mathematics and the natural world, Mukunda reaches a provocative conclusion – 'because mathematics is essential to describe nature we have to adopt a more open view of existence and reality, going beyond space, time and the tangible .... Mathematics then, like Nature, has also an intangible level of existence.'

P. Balaram