The Rosetta Mission – The Link Between Science and Technology
Dr Andrew Morse – The Open University

The tenacity and shear optimism of space scientists is really admirable. They put a lot of effort into developing the proposal for an experiment on a spacecraft (most get rejected) then they spend years developing instruments which need to be at the forefront of technology, but they have to use space-qualified electronic components which are necessarily using decade-old technology. After maybe ten years of work they put their precious baby on top of a rocket which may explode or crash if any one of hundreds of thousands of components working at their limits of endurance do not behave perfectly. Then, as in the case of Rosetta, and assuming the launch is successful they wait maybe another ten years while the space craft finds its way across half the Solar System to an almost invisible lump of black ice a few kilometres across and travelling at an extremely high speed. You then drop your delicate package onto an uneven, rock strewn surface, hoping that it will land somewhere safe…and manage to stick it down in an orientation where the instruments can do the job they were designed to do. If they don't, well, there may be another space craft coming along in twenty years.

We have, I think, became rather too used to extraordinary space missions actually succeeding and forget what a white-knuckle ride most must be for those who bet entire careers on the chance of nothing going wrong. Well, Rosetta as a whole was an extraordinary success, though the Philae lander, for which Dr Andrew Morse help design the Ptolemy mass spectrometer, did not work completely as expected, for it turns out to be very difficult to stick yourself down on a comet. The engineers were told that the surface might be anything from the consistency of candy-floss to hard concrete, and in fact it turned out to be an impossible combination of both: a layer of extremely soft material overlaying exceptionally cold and very hard ice. None of the several hold-down methods managed to grab on, so Philae bounced across the surface, claiming, as Dr Morse pointed out, the first four landings on a comet. It finally ended up on its side, in the shadow of a boulder, which meant that the solar panels could not recharge the batteries, so they were limited to a day or two of data gathering. Given all these formidable difficulties it highly impressive that about 80% of the science targets were accomplished. In fact, some of the technological wizardry for getting samples into the mass spectrometer turned out to be unnecessary, because the first impact kicked up so much dust that the instruments were able to sniff the composition while Philae was tumbling. Nevertheless, it is unlikely that this method will be adopted as the favoured method of collecting surface samples in the future.

We should not forget the science, which after all is why researchers go through this process. Comets are pretty much guaranteed to be the (more-or-less) unprocessed remnants of the original material out of which the Solar System formed. Everything else we can reach has been extensively cooked in various ways. Of course, it is not quite that simple: comets may have been sitting a few degrees above absolute zero for four and half billion years (not an environment is which we expect chemistry) but have also been exposed to a small but significant flux of high energy cosmic rays for all that time. Their surfaces (as Philae confirmed) may consist of various polymerisations of the low concentration basic organic compounds (e.g. methane) that form part of the bulk composition. That is probably why they are so black - think of the bottom of a pan left on the cooker for far too long. However, as the comet approaches the Sun and heats up, volatile material from below the surface evaporates and emerges as jets, which can be sampled by the Rosetta orbiter. Rosetta shut down in 2015, its mission accomplished, but the science goes on and will go on, no doubt until the next spacecraft attempt a comet landing (maybe in twenty years from now?) because the data from Rosetta is unique and of enormous importance to those who seek to understand the original of the Solar System.

Dr Morse presented the society with a fascinating and extremely well illustrated lecture on the work of this exploratory space project.