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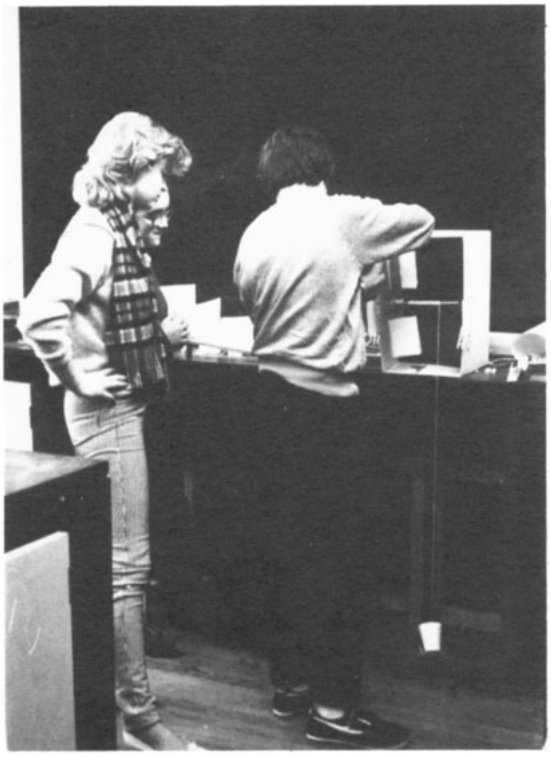

Above and **below:** students at work on the programme

For four successive years now between 30 and 40 girls and boys, in roughly equal numbers and aged between 13 and 14, have been coming to the University of Sussex on ten consecutive Saturdays with pleasure, excitement and dedication in the face of Sussex winter weather—even to the extent of braving the occasional blizzard—just to spend a couple of hours doing more physics than they usually did at school. Perhaps that is not too surprising, but matters might seem different when you consider that the 'extra physics' covers, for instance, ideas about how to count atoms in a perfect silicon crystal as the atomic planes are moved sideways in an x-ray beam and, furthermore, that the children are warned not to describe this as a method of determining Avogadro's number in any of their O-level examinations for the foreseeable future. They are also set the task of building up the periodic table of the fundamental particles from an assembly of various coloured cardboard discs and a recipe book and in the process they can award themselves Nobel prizes when they come up with the prediction of omega-minus baryon and the charmed quark.

Extra Saturdays at school

These 'extra Saturdays at school' sessions are part of the series of Master Classes in Physics for Young People run at the University of Sussex on behalf of the Royal Institution with financial support from Shell UK Ltd. The guiding aim of the series was to take pupils from local schools in Sussex who showed talent in physics at an early stage and to give them added pleasure and perspective by exploring some of the more far-reaching ideas of physics which might probably never be covered in their school careers but which could with care be explained to them. The old adage 'Physics is fun', enshrined in the title of Jim Jardine's book, was held to be the most important principle in organising the Master Classes—particularly since failure to transmit that feeling to successive groups of highly motivated pupils would have a catastrophic effect on the role of physics in Sussex schools in the coming years. The selection of the pupils was carried out by the Science

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Advisers of East and West Sussex for pupils from the state sector. Roughly one-quarter of the places were reserved for pupils from the independent sector, selection in that case being by correspondence with the teachers involved.

Clearly, university physics lecturers would have difficulty in striking the correct level of presentation of quite advanced ideas to 13- or 14-year-old children. At the outset, we sought help through the Science Advisers of East and West Sussex from local school teachers and, where possible, we chose to work with teachers who had graduated recently from the University of Sussex. Outline schemes for the programme of the master classes were discussed in detail before a final chain evolved on which to hang the programme. This involved, first of all, looking outwards from the Earth and its immediate environment to the distant stars to examine how their properties might be determined just using the nature of the light given off by them. The need to understand a lot more about the properties of light and the role played in its generation by the structure of the atom could then lead in to investigating the realm of the photoelectric effect and the wave–particle duality concept. At this stage, the clear lure to look inside the tiny dot of matter at the centre of the atom could not be resisted and the world of the internucleon force was explored down to the level of the quark and beyond. The 'gee-whizz!' level of that initial talk about the Universe could then be set in a rather tighter context by looking at the way in which distance scales could be assigned in astronomy. The final element of the chain came in different forms in each of the Master Classes—one year it looked at where the sun obtained its energy, another year at the role of gravity in black holes and recently at how the ideas of the fundamental particles that were discussed in the talk on the makeup of the nucleus could relate to the behaviour of the Universe just after the Big Bang.

Each lecturer on the classes had a school teacher experienced in teaching this age level assigned to him to work out in detail the content of the talks, trying to hold them to no longer than 45 min to keep the attention of the young pupils. Some of the teaching aids developed for the talks were superb—a half size snooker table doubled up as a mass

Programme for the winter 1986 series

October 4 Talk from Dr P J Christiansen on 'Solar system research' with film of the University of Sussex involvement with the AMPTE satellite experiments, followed by laboratory work on wave phenomena (velocity of sound and interference of light).
October 11 Talk by Dr A D C Grassie on 'Waves of all frequencies' followed by continuation of the laboratory work on wave phenomena.
October 18 Talk from Professor K F Smith on 'What's inside the atom?' followed by tours of the laboratories of the research students involved in supervising the laboratory work of the children.
October 25 Talk from Dr P G Dawber on 'The puzzle of spectral lines' followed by 'egg-race' project activity.

November 1 Continuation of 'egg-race' project activity.
November 8 Continuation of Dr Dawber's talk followed by laboratory work on atomic properties (energy levels in atoms, spectra at optical and x-ray frequencies, photoelectric effect).
November 15 Talk by Professor R J Blin-Stoyle FRS on 'What's inside the nucleus?' followed by continuation of laboratory work on atomic properties.
November 22 Talk by Dr R C Smith on 'How far away are the stars?' followed by construction of simple crystal set as project activity.
November 29 Talk by Dr D Bailin on 'Fundamental particles and cosmology' followed by completion of construction of crystal set.
November 26 Visit to the Royal Institution.

The author with students during one of the Master Classes *(photographs in this article courtesy Shell UK)*

spectrometer and as an accelerator for the simulation of Rutherford's study of the nature of the atom. A brief two page summary of each talk was given out to the children at the end of each talk.

Physics is an experimental science...

But physics is an experimental science and the swathe of talks on the various topics, no matter how well tailored to the attention span of the audience, could well have been off-putting. So in the other half of the two hours each Saturday the children set about trying a variety of experiments, many of which also were discussed in the talks. The experiments from the first year practical class at Sussex had in the past been used with sixth-formers on summer schools and with O-level pupils on several WISE courses. Deciding to use these was simple, but the help of the local teachers was invaluable in getting the descriptions of the experiments written at a suitable level to be given to the pupils in a booklet at the beginning of the master class series. Research students with experience of demonstrating the experiments to undergraduates were trained to discuss the ideas at a far lower level than they had previously been accustomed to tackle.

Even with the inclusion of this experimental work, the prospect of boring the children by repeating each week the same pattern of work was ever present and it was decided to vary that second half so that no more than two Saturdays in succession were spent doing the same kind of thing. One day, the research students took the pupils off to see 'real physics' in action in their own research laboratories and projects. Another couple of days were spent on an 'egg-race' activity selected from the admirable BA booklets on possible egg-race topics (*Ideas for Egg Races* and *More Ideas for Egg Races*, British Association for the Advancement of Science, 23 Savile Row, London). Groups of three pupils were given a problem in a sealed envelope along with a box full of a miscellany of materials and had two to three hours spread over a couple of weeks to solve the problem in a relatively competitive atmosphere. However, any possible tension was reduced after the judging when they discovered that the nature of the first and second prizes was really just the gold and silver bows on chocolate cream eggs, which every one else on the class received unadorned.

Voices from the air

The apparent dominance of 'pure physics' in the master classes worried us to the extent that after the first year of the classes the introductory 'gee-whizz!' talk on the Universe was replaced by one on Sussex University's involvement in upper atmosphere research, both the rocket and satellite experiments. A film was also shown of the construction and operation of the AMPTE (Active Magnetospheric Particle Tracer Experiment) satellite experiment with which the lecturer had actually been involved. The final couple of half sessions of the master classes were given over to the construction of a crystal set which, on plugging into the family TV aerial, to the children's amazement gave voices from the air for free without the need for batteries and which could, of course, have a vastly better aerial system rigged up at little extra cost.

A pleasant break over soft drinks and biscuits each day tapped into the constant barrage of question and answer that had begun after each talk.

Near the end of each master class series, the children were taken to the Royal Institution for a visit which included a lecture, a tour around the Faraday Museum and a visit to the research laboratories of the institution. This gave them a magnificent historical feeling of the role of science as they savoured the atmosphere of the oldest scientific institution in the UK in the context of its current research activities. The return bus trip gave an ideal opportunity for the children to complete a questionnaire on their responses to the overall master classes programme, which turned out to indicate quite a pressure for more sessions spreading over two or more terms—quite a credit, bearing in mind our determination not to bore the children with 'extra school'! Some of the children have since returned to the university on work experience schemes from local schools to work alongside the master class lecturers. The careers of the pupils taking part are being followed, but only one group has as yet passed into the higher education sector.