

*Professor Ellis.* I'm 100% with you. [Laughter.]

*The President.* Let's thank George once again for a great lecture. [Applause.] Now, my final announcement before we break for tea and then the community forum, is just about the NAM next year, which is going to be held at the University of Glasgow from April 12–16. This one has been, I think, a tremendous success and Glasgow have got a challenge on there. Anyway let's all meet together in Glasgow next year. [Applause.]

[The A&G meeting was followed, after tea, by the STFC Community Forum.]

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## STFC COMMUNITY FORUM

A. C. FABIAN, *President*  
in the Chair

*Panel:*

A. M. CRUISE (*Chair of Astronomy Grants Panel, STFC*)

R. GILMOZZI (*PI of E-ELT, representing ESO*)

J. KRAUTTER (*EAS President*)

K. O. MASON (*CEO STFC*)

D. SOUTHWOOD (*ESA Director of Science*)

*The President.* We'll start with our distinguished panel by getting each of them to give a two-minute introduction, but I'll give Keith Mason five minutes as we'd like to know a little more about the budget. I have set up the Astronomy Forum, which represents the astronomy departments in the UK (astronomy being defined as being anything done above the clouds). The Astronomy Forum has already met twice and I think it's going very well. We are already engaging with STFC and other bodies, and there is more detail on the RAS website.

*Professor D. Southwood.* The ESA Science Programme and Robotic Exploration are of interest to those here. There is good news and bad news. The UK needs to think about how we will come through the selection process for Cosmic Vision and how this affects national priorities. We are already beginning to get involved in Mars exploration with our US colleagues and we can use this as a buffer, but they have to do what they want along with what we want, and I think that the UK is psychologically better at that than some of our European colleagues, so I look for leadership in this community. We have short-term major financial problems because we started both *Bepi-Colombo* and *Gaia* at the same time. *Bepi-Colombo* is over-budget and needs attention, but the good news is that the budget will increase annually by 3.5%. We will need to make some serious decisions quite soon about the next tranche of missions for 2017/2018.

*Professor A. M. Cruise.* I am currently Chair of the Astronomy Grants Panel. It's an agency that makes many people happy; unfortunately it makes twice as many people unhappy. I'm willing to take questions on the process involved but this is not an appropriate venue to discuss individual grant applications.

*Dr. R. Gilmozzi.* As Principal Investigator of the *ELT*, I wish to underline the importance of the UK's membership of ESO. It has brought a lot of know-how,

instrumentation, and the *VISTA* telescope; and it is complementing the Paranal observatory, which starts operations soon, and it plays an important part in the *ELT*.

*Dr. J. Krautter.* I am President of the European Astronomical Society. The European approach has been shown to be a powerful way of producing new facilities and I would like to talk about the European perspective on UK astronomy. UK astronomy is on a very high level but the UK cannot exist on its own. The UK is not only a member of ESA and ESO but also of European networks like ASTRONET, OPTICON (Optical-Infrared Coordination Network for Astronomy), and RadioNet, and, in addition, the Royal Astronomical Society, the society of British astronomers, should be more integrated into Europe. We need more joint meetings and I'm happy that the RAS has given us the chance to present ourselves at this meeting.

*Professor K. O. Mason.* I'd like to summarize yesterday's budget — what it did and did not do for the science programme generally. The science ring-fence was protected, which was a huge win given the current economic turmoil. This underlines the Government's commitment and indicates that the Government perceives that science research is a key element on the road to recovery. We now have to deliver on our promises and future success will be judged on these expectations. Economic impact means making the most of what we do. This will be a challenge to everybody in the research base. I believe that there is a lot of expertise from people in this room and in this country which is vital to the wider health of the country's research base. The good news is that we have been putting together structures within STFC, which, whilst not universally popular, do make a gateway for you to make an impact in a very visible way and which justifies our existence. There are challenges ahead, one of which is the catastrophic devaluation of the currency over the last few months, which clearly impacts upon the affordability of the astronomy programme. This could have been very serious, but I can report that the Department for Innovation, Universities and Skills has made great efforts to cover the gap in the finances for next year to the tune of about £30m. Even so, because of the fluctuations, we will have to find £10m in this current year and we are doing that by slowing the programme and making other decisions at the end of this month. The other message is that no one knows how much money will be available in the future. It's vital to know now what our priorities are in case sudden decisions have to be taken, as they often are. We'll be considering these questions over the next few months.

*The President.* Thanks. With regard to prioritization, perhaps Michael Rowan-Robinson might like to make a comment.

*Professor Mason.* We're setting up the long-awaited Ground-Based Astronomy Review and Michael has agreed to Chair that.

*Professor M. Rowan-Robinson.* I have taken on what everybody has warned me is a poisoned chalice, and there will shortly be a public web page telling you about this review. It's a kind of mini-decadal review looking as far ahead as 2020 and we want to report by October. The main element will be to consult with you and we are already preparing a document which we want to publish by the end of May. You then have three months to input your views on what facilities you would like to see over the next decade and then we will pull it together for the report.

*The President.* Thanks, Michael. So let's throw this discussion open now for questions from anybody to any member of the panel.

*Dr. M. Dominik.* This is a question for STFC mainly, but everyone else is encouraged to comment on it. On Monday the Science Minister, Lord Drayson, said that the UK should be proud of the quality of its scientists

and their productivity; they are amongst the leaders in the world, and future prosperity will depend increasingly on the country becoming a knowledge-based economy. It seems obvious to me that we need to make efficient use of the existing creative potential of people as a crucial priority to drive innovation. In particular, what are the current opportunities for young talent and what measures of improvement should be taken?

*Professor Mason.* I think we all agree that we need to make use of talent, particularly young talent, as we are looking to the future and this is a skills issue. Young people should go into science because it is fascinating and we love to find out new things, and also being smart is the only way to build a future for our descendants. We need young people for a sustainable future, to combat the challenges of climate change and an ageing population. The other point, as anyone involved in science will know, is that science is not a linear process. To have a resilient system in the future we cannot afford to specialize too much in one direction, such as the influx of particle physicists into banking, for instance, so we need a breadth of knowledge, expertise, and activity. I'm very keen on the interdisciplinary approach — everybody benefits.

*Professor Southwood.* I agree with Keith. Don't expect to spend a career in science repeating your PhD endlessly. Be open to moving, and think about what facilities you can exploit. The older scientist tends to get bogged down protecting the institution that he or she works for. Science evolves as society's needs evolve and astronomy evolves in parallel, as our society needs astronomy. In 40 years' time, astronomy will be different.

*Professor T. Ponman.* Keith, you said that we need to be clear about our priorities given the present and future uncertainties. I, for one, am a little confused as to whom the STFC strategy document is for. A document was produced which we thought was a draft strategy document when in fact it was a consultative document. That's not what the communities or the panels will need for setting priorities internally. What Michael is going to be doing will set genuine priorities within the programme. I wonder what the rest of the picture is. How do you see a strategy being developed which will actually form decisions within the community about the relative priorities of different projects and facilities?

*Professor Mason.* The target is one year from now. A glossy document is being produced for the end of the month but one of the problems is that the strategy never stops, it is evolving all the time. A document to which the panels can refer is about a year away but if we can do it by October that would be more comfortable, but of course this is a big job and consultation takes time to do properly.

*Professor Ponman.* Are there other elements in addition to the Ground-Based Review which will contribute to that process?

*Professor Mason.* There will be but I can't yet tell you exactly what will happen.

*The President.* Next question. [Silence.] So everybody is happy about what has happened. [Laughter.]

*Professor K. Nandra.* I have a question about Cosmic Vision. This is somewhat different from previous research endeavours in that ESA is asking member states to put in serious money for technology development in advance before the programmes are selected. As far as I am aware there is no evidence that the UK is doing that. My question to David Southwood is whether he is concerned that the UK does not appear to be pulling its weight in this exercise; and hence the question to Keith is, will this put the UK's scientists at a disadvantage when the selections for Cosmic Vision are actually made?

*Professor Southwood.* This is not a planted question! We've gone through various phases. There was, at one time, a fair bit of money for blue-skies research and, if you wanted funds for space research, you had to supply proof of principle, at least proof of technology, and that was best done in the university laboratory, at least in this country. The wheels fell off the wagon 10–15 years ago when ESA started to devolve work, and this started to corrupt the system. Certain member states say that if you seed this work then you've got to carry right through and build the entire instrument. We've done that for *JWST* and *NIRSPEC*. We've asked our advisory committees and even our Council and we are told "No, instrumentation should be built in the universities and funding should come from the national side". The problem is that when potential technologies are being tried out early in the project, if we seed too much we are seen as biasing the system and therefore become responsible for looking after the system. If we don't get national funding spent at this point we get the 'not invented here' problem when we hand over the project. It's been a long-standing problem and it goes in cycles. There is a solution and that is to shift the responsibility entirely to ESA. Personally, I think this kind of work is best done independently in the science community and that requires turning to Keith for the money for blue-skies instrumentation.

*Professor Mason.* For Cosmic Vision we will put money into appropriate studies. It's not as much as we would like to put in and more than some people would have us put in. The wider question is generally one of basic technology development in this country, which applies both in space and other areas. We have got to a stage where we are not putting enough into that kind of development in order to secure the future, particularly in the space area. Timescales are long and we only see the fruit of today's investment in about 20 years' time. My personal view is that we do not spend enough in this area and the only way to do a better job is to prioritize. Trying to spread the jam too thinly is a recipe for disaster and we should focus on doing a few things better and we need to debate what these things are.

*Professor Cruise.* I just want to make a demographic point. There is a noticeable decline in the number of people coming through with instrumentation skills. The universities have not done a very good job in providing a career structure for people with technical skills and the number of students wanting to do courses which include hands-on instrumentation has been dropping. There are lots of reasons for this. The Government, it seems, now want to get back into manufacturing industry again, and of course the university departments must react to that policy change, but with an inevitable delay built into the process. This is extraordinarily dangerous for the theoreticians and modellers because they then will not have front-rank instruments in the future unless the technical support is in place. I hope the various analyses and strategies will take account of the urgent need to replenish this resource of very important people.

*The President.* The basic answer I seem to be getting is that funding is in place for Cosmic Vision. Is that what you understand, Paul?

*Professor Nandra.* That's not really what I understand. What I was told was that the majority of funding for Cosmic Vision had been put on hold.

*Professor Mason.* I have already described the short-term budgetary issues and everything is going to get caught up in that, but the bottom line is that there is provision for Cosmic Vision. It could be more but it's sufficient.

*Professor E. Brinks.* I have a question for Mike Cruise. How is the grants line, particularly funding for PDRAs, going to fare in the near future?

*Professor Cruise.* Unless I get some new instructions, the level will be the same as that which I discussed with the office in the last month or so. If that

is the case then the 25% cut which was made two years ago will still be in place but it will not be any worse than that. We are now in a situation where the panel can only fund world-class research. The UK has been able to build an astronomy base over the last few years by funding things which are more speculative, just below this level, and these have now developed into facilities of world-class quality. I have placed my report on the STFC website (<http://www.stfc.ac.uk/resources/pdf/AGPState.pdf>) and in it I worry for early-career scientists. There are structures in the evaluation of grants that inevitably tend to lean towards people at the peak of their career rather than those just starting out, and it's difficult to alter the grants system to favour young researchers in the way we would like. If the current level of funding carries on for many years into the future then it will be very serious. I think STFC will try to maintain the current level or even try to improve it in the future but we are all limited by the economic circumstances. To sum up, I've not been told of any change in the grants line, but it will be a very tough grants round.

*Professor Mason.* I echo much of what Mike says. It's a highly competitive line but it's also an expensive line and a significant part of the funding. It's all about choice and the only way to put more money in to improve grants would mean removing money from someone else, and this is far from easy. We could consider the way we handle grants — is there a better way of doing it? And as Mike has noted, there are in-built systemic tests in the awards system which fail particular people at particular stages of their careers. Can we do something different? I'm very happy to have such a debate and to discuss how to make best use of what is available but everything is now getting much more expensive much more rapidly than the amount of money is increasing. It's a fact of life and it means hard choices.

*Dr. D. S. Brown.* This is directed to anyone on the panel who wishes to answer it. We've talked about challenges for the future, financial or otherwise, and there are perhaps many people wondering what we can do to contribute to a solution. What is your advice for people like me, perhaps the younger, junior astronomers?

*Professor Mason.* When David and I talked about multidisciplinary research, I didn't mean hopping between disciplines; but one of the best things anyone can do is to spend time talking to people in other disciplines, about how we can help each other. You would be amazed how much leverage there is. This can also lead to easing of financial problems too because you can have a diversity of income, and you and your university will be more robust. Go out with open minds and use your range of skills, which are hugely in demand; this is a powerful thing that we should take more advantage of.

*Professor Southwood.* I encourage you to take an interest in contacts outside the university, particularly in the political world — an MP might one day become a minister, so if you believe what Keith is saying, get it out there in the minds of people who in the end vote for or influence budgets. This has to do with communicating to people in the political process, independent of their party affiliation: they will have an influence. This can be done not in an aggressive, political manner, but as a spokesman for science and technology. And remember, young people get more attention from MPs.

*The President.* Remember your fellow students may be in charge eventually; two of my fellow students are sitting on the panel here, and I would never have dreamt back then that they would be! [Laughter.]

*Dr. Gilmozzi.* Another activity that is important for the development of astronomy is to explain and bring our subject to the general public; after all, what we are doing is something that contains excitement, discovery, new

knowledge — what we are paid, in a sense, to produce for people. We must make the effort to bring our subject to the public.

*Professor Carole Jordan.* May I ask Keith what portion of the total STFC budget goes on grants, and has that changed in the last five years?

*Professor Mason.* Roughly, 60 million pounds a year is spent on grants, out of a total budget of about 400 million pounds.

*Professor Jordan.* So why is it not possible to make cuts from the vast majority, since the grants line is what supports people who do the science? The ideas come from individuals in universities or government establishments that work with the universities. One thing for which I fought tooth and nail when I was on the Research Council is that the grants line was the most important line in the whole budget, and it's an easy target — if you tie up too much money in capital projects, and you don't leave enough money to support individual scientists on the research that can be done, particularly young scientists who have new ideas, you will run down the quality of the research that is done; and so I hope there is still someone on the Research Council who fights for the grants line. [Applause.]

*Professor Mason.* Well, there are two people on this panel who fight for the grants line too — but the majority of our money goes on international subscriptions. A lot of that goes to David [Southwood] here. [Laughter.] The amount that I turn over to David is out of my hands; it is fixed by the agreement by which the UK joined ESA, and I do not have control over whether that budget goes up or down, since it is done by majority voting on the various councils. Another large chunk of money, about the same as the grants line, goes on domestic facilities, which are long-term investments with relatively little flexibility. I hear what you say, Carole, and I agree with everything you say, but it comes back to hard choices — the only way to put more money into grants in the current climate is to stop doing something else: you have to tell me what to stop doing.

*Professor Jordan.* Every time you have a new project coming up, or you are looking at new projects within the time frames that are relevant, more care should be taken that when new things are taken on they do not imply a drop in the grants line.

*Professor Mason.* You never have that luxury because the timescale for projects in our field is typically a decade, and we don't even know what the budget will be in a year's time. We have to have a balance between the people with the bright ideas and the facilities with which to execute those bright ideas. Do you want to have an *ELT*? The astronomer will say 'yes', but you have to balance that with having people to use that telescope, and that balance is very difficult to get right; ultimately, the only way to put more money into grants is to stop doing something else.

*Professor Cruise.* Carole has hit the nail on the head. From the operational perspective of the grants panel, we see the result of the last decades of facility and instrument building — for example, if we look at *Herschel* and *Planck*, the UK has probably spent about 100 million pounds over the past 10 years contributing through ESA to those instruments, but we find ourselves able to spend only 3 million pounds supporting the science that comes from them. The ratio is that extreme. I think one of the biggest problems STFC has to face in formulating its strategy is working out what that ratio should be. If you really want to exploit some of these facilities, you will have to build less. But the current situation is very depressing: having spent 100 million pounds on these facilities, we are really limited in the number of post-docs that we can get

to benefit from them. It is eye-wateringly sad to see the ratio being as large as this; however, this is not something that is an ill judgment on the part of the STFC — this is the result of the policy of the last 10–15 years. Some strategy for getting this correct needs to be found for STFC to maximize the science output from its programme.

*Dr. Krautter.* I can assure you that there are these problems in other European countries too. I realize, as Keith said, that one has to find a kind of balance; but from this discussion, I get the impression that a significant fraction of the UK community feels that the grants get decreased too much. I really warn that if you decrease the grants, you will have a lot of good and excellent instruments, but you will soon miss the people to exploit them fully. I really warn that the grants are the weakest link in this chain.

*Dr. C. Owen.* I wanted to follow up the question that Paul asked. The issue with Cosmic Vision and the new way that ESA operates is fine in principle, but STFC did not prioritize very strongly for Cosmic Vision, and as far as I am aware, has actually funded all the missions, but at a relatively low level. What concerns me is that there is a down-select coming up, and rumours are that that down-select will not down-select very much. Will we find ourselves moving into the next phase of Cosmic Vision with funding being spread thinly?

*The President.* Do you have too many things competing?

*Professor Southwood.* The point of a competition is to have winners and losers; in fact, with space missions, historically, not too many things really lose, but they get strung out in time. As an example, two predecessors of what became *INTEGRAL* lost twice before that mission finally emerged in the form that it flew. Probably the most serious issue, to be discussed by the SPC in June, is the fact that if you do two medium missions, one after the other, how much competition have you introduced? Are we considering too few missions?

*Dr. Owen.* If there are, say, four missions still in competition in January, will STFC still find enough money to fund the studies that are required to build those missions, even though some of them will fall by the wayside?

*Professor Southwood.* It's not quite like that, and STFC have not done too badly in communicating with me where they feel their community priorities are with some of those missions. In some cases, they have clearly indicated that the UK cannot provide appropriate long-term funding, and I am shifting the work to Spain, Netherlands, and so on, and this is a productive way for Europe to operate. In fact *INTEGRAL* was a good example of this, since it was not highly prioritized in the UK and the work was shifted to Italy, France, and Germany. If we do it early on, we can manage it so that Europe as a whole benefits. I wish I could get the same level of communication out of some of the other funding agencies in Europe.

*Dr. Krautter.* I fully support this attitude. The UK does not have to be involved in all ESA missions — that's the point of collaboration. There are many countries involved; it is better for one country to do fewer missions well than to try to cover all missions.

*Professor Monica Grady.* I'd like to change the subject and address a question to all the panel members. It's a comment that has been made at every NAM I have been to over several years. I am looking at a panel of the finest, venerable, European manhood [laughter]; this afternoon we had a medal session when all but one of the recipients was another fine example of global manhood. When are we as professional scientists going to grasp the nettle and realize that we have a vast resource of womanhood? And how can we make our science more accessible to non-whites and to women? We have to be looking at options for

flexible working, breaks in fellowships, and so on; it's not an easy problem, but it is one to which we have been paying lip service in this community for years. We have no fellowships which specifically address the needs of women returning to work in STFC; the Royal Society does, but none of the research councils. We also need to make our field more attractive for non-whites. [Applause.]

*Professor Cruise.* I support very strongly what Monica said. I chaired the RAS awards committee this year, and I ask people when responding to the RAS for requests for nominations to think carefully about nominating people who are not pale, male, and stale [laughter]. The universities have a rôle here too. A year or so ago, I was advised in a certain matter of the salary level of a first-rate woman professor at a university, and I knew roughly what the male salaries were; and I was shocked at the disparity. The universities need to step up and deal firmly with the problem of equal pay. Everybody needs to try hard to break through this problem. Those people who have had the opportunity to work with women returning from having a family will know that there are benefits to the group as well as to the women themselves.

*The President.* Thank you, Monica, for raising this. Certainly in terms of the graduate-student intake, about half of the intake is now women, but at the professorial level, it is a few percent, as you have stressed. We need to do something about this, but you're right, we are starting too little too late, and we need to do much more.

*Professor Mason.* I don't think I have much to add; I agree with what Monica said. When I was head of a university department not so many years ago, we had a ratio of 2:3 women to men. My experience was that this high ratio of women staff made a huge positive difference to the dynamics of the department, how it worked; and I want to increase the ratio of women in the field. It's a very hard problem, as we all know. We have to fix it collectively, and it is all about attitudes, and recognition of the problems that women face.

*Dr. Gilmozzi.* I am here representing the Director General of ESO; of course, two years ago, the ESO Director General was a woman. The solution starts with accepting the fact that there is a problem. At ESO, this is beginning to be the case; we are far from an ideal solution, but there have been studies of, for example, the problems of motherhood during fellowships, *etc.* This is being actively studied, with discussions taking place with staff, leading to proposals to modify the rules. There is still a long way to go, but realizing that the problem is there is the first step.

*The President.* Carole, do you have a point on this one?

*Professor Jordan.* Yes I do! [Laughter.] When I was on a certain committee, there was an example of one woman on the committee who had children and she asked if child-care expenses could be claimed back; and most of the rest of the committee decided this would be too much. I complained that one could claim expenses to park one's car, but not one's child!

*Dr. M. M. Bisi.* I am a young scientist working in California — I am not in the UK since there is no funding for it; I was lucky to get a job in the USA, since there are few in Europe. What are the plans of STFC to rectify the problem of keeping young scientists in the UK?

*Professor Mason.* It's a good point, and firstly I would say that mobility is important: I spent part of my career in California, and in many respects, I wish I were still there. [Laughter.] We should take advantage of opportunities for mobility. We want to make the UK a place where bright people want to come and live and work. This takes time, but the current government has invested strongly in science over the last ten years, and it is showing: for example, the

*Diamond Light Source Facility* is a beacon, and it impresses and attracts people. We need to extend that ethos to everything we do, to aim to be world-leading and attract others.

*Professor P. A. Crowther.* A year ago there was criticism of STFC's communications, both with international partners and with the community. It's good to hear from David Southwood that communication with ESA by STFC is much improved. I do have a concern from a community perspective that although STFC's website is much prettier than it was six months ago, we are still not quite getting the full picture: examples are the cancellation of *Clover*, and the announcement of the Ground-Based Review today. We seem to be getting only a partial picture in the communications from STFC. I'd like to be done out of a job — I'd like to see more information made more transparently from STFC.

*Professor Mason.* You're doing a great job: whenever I want to find anything, I go to your blog [laughter]. There is a serious issue here, and it is about transparency and openness: but there is a tension between openness and the timing of announcements. Government departments deal with this by clamping down on everything to prevent leaks; we have a culture where we talk to people, so one of us might talk to a friend and it appears on your blog! Is that good or bad communication? Do we want to clamp down on everything? That would imply much less interaction with the community. Terry [STFC Director of Communications], would you like to comment?

*Mr. T. O'Connor.* I agree with Paul that the website needs to be improved. The goal is to ensure that the website, which is our primary means of external communication, is clear and supposed to make sure you can find the information that is relevant. We are working to improve it and provide you with more information about what's going on; last year we accepted the message that we could have done better with regards to consultation. We are trying to do better, and we hope you are noticing the difference.

*The President.* The information flow is considerably better than it was a year ago, and Paul's website helps.

*Professor J. Hough.* Just a comment on what Monica said about fellowships: in fact, we are very flexible in STFC with fellowships with regard to any form of part-time working, and we are encouraging women to come back. You'll find in our adverts that we welcome returners to apply, and this coming year we intend to offer 6-month grants for people to study up to prepare for fellowship applications.

*Professor T. Shanks.* I wanted to ask Keith and Roberto about ESO discussions concerning a penalty charge on *VISTA*. There are rumours going around that diplomacy has been a bit up and down, and I wondered if you could tell us if there is anything the community can do to help.

*Professor Mason.* We are in discussions with ESO about this; it is a non-trivial issue. What we are concentrating on is getting *VISTA* up and running, and that is looking good, with the usual teething troubles one expects to have with a complex instrument; we hope that by local summer time we will be starting survey work with it. ESO is our observatory, and we want to be a good partner within ESO, but we recognize the value of *VISTA* and we wish to find a mutually acceptable way forward that supports European astronomy, and not get hung up on things that are backward looking.

*Dr. Gilmozzi.* These discussions are well above my pay grade; I can say that the work towards reaching the start of real science operations has been going on very actively, regardless of any discussions there might be at other levels, and

the cooperation between the teams of *VISTA* and Paranal has been really very productive.

*The President.* It's time to bring everything to a close. Let me thank the panel who have answered the questions that have been put forward. [Applause.]

On behalf of the RAS and of you all, I would like to thank the NAM meeting organizers: the Local Organizing Committee, Hugh Jones, Janet Drew, Elias Brinks, Jim Hough, John Atkinson, Bob Chapman, and Mark Sarzi; the Scientific Organizing Committee, Janet Drew and her 15 colleagues; and all the many others, including the students, who have contributed to the success of this meeting. It has been a great JENAM and we thank you very much. [Applause.]

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SPECTROSCOPIC BINARY ORBITS  
FROM PHOTOELECTRIC RADIAL VELOCITIES

PAPER 208: HD 3065, HD 40602, HD 134738, AND HD 216525

By *R. F. Griffin*  
*Cambridge Observatories*

The binary natures of three of the stars discussed in this paper (HD 40602 being the exception) came to light in the course of the 'Clube Selected Areas' programme or its unpublished extension; they are probably (certainly in the case of HD 216525, which was observed by *Hipparcos*) giants. HD 3065, which is less than  $5^\circ$  from the North Celestial Pole, has an orbital eccentricity of 0.66 and period of 1285 days. HD 134738 has an eccentricity that is even higher, 0.78, whereas its declination is more than  $90^\circ$  lower, and as its period (341 days) is close to one year the sudden periastron passage occurs when the system is unobservable in several successive seasons, a circumstance that has created delay in the determination of its orbit. HD 216525 has a circular orbit with a period of only 16 days; it has a projected rotational velocity of  $29 \text{ km s}^{-1}$ , and could well be expected to exhibit RS CVn activity, although none has been reported. Finally, HD 40602 is a different sort of system, being an Am-type binary which was taken onto the observing programme in what was initially intended to be a 'service-observing' operation. It has proved to be double-lined, with a period of 61 days and an orbital eccentricity of almost 0.8, which is believed to be the highest yet known for a binary with a period less than 100 days.