# DISCUSSION

*G. L. Kulcinski*[1]—You stated that gases are necessary for void nucleation. Certainly we are all concerned about neutron produced gases such as helium and hydrogen, but could you say a few words about the importance of residual gases such as oxygen and nitrogen on the nucleation phenomena.

*R. Bullough (authors' closure)*—We believe that such residual gases could assist in the nucleation process. Also, the vacancies clearly can aggregate as voids around small incoherent precipitate particles.

*J. W. Corbett*[2]—Would those who spoke on theories please comment on the difference between the theories.[3]

*R. Bullough (authors' closure)*—This is a rather difficult question to answer at all briefly, and from the oral presentations alone it is not really possible to assess all the detailed assumptions in the various theories. It will, however, perhaps help if I mention an important feature of the Bullough and Perrin model of the void growth process which seems to be absent from the other theories.

The special feature of our approach is that we consider the actual flow process in the geometrically defined neighborhood of a void. That is, we actually solve a spatial migration problem and do not resort to a completely "kinetic" model with *all* the sinks smeared out into a continuous distribution. The void is a well defined, large geometrical defect and can be defined explicitly.

The importance of including the geometrical shape of the void in the theory can be seen by our predictions concerning the effects of cold work. Thus at low doses cold work will cause an immediate reduction in the volume swelling but this decrease, below the solution treated (low dislocation density) material, is not sustained, and at high doses the volume swelling for the cold-worked material can exceed that of the solution treated material. This relatively rapid swelling when the dislocation density is high occurs because the spherical nature of the region in the neighborhood of each void is essentially obscured by the high dislocation sink density.

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[3] See also discussion by Li et al, pp. 347–361.

This is an important effect and can hardly be expected in models in which the voids are themselves smeared out.

The possibility of premature saturation, though not explicitly discussed in our present paper, can also be conveniently included in the present model. We believe this will occur when the void concentration and the size of the individual voids reach a critical value and cause a sudden drop in the dislocation density. This can be included by simply including a spherical shell of varying thickness around each void, inside which there are no dislocations; dislocations inside such a domain would be pulled into the adjacent void by the image forces. Swelling will terminate when these dislocation free regions begin to overlap. A precise, quantitative estimate of this effect is under way at present.