PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY

Department of
MATHEMATICS

Address reply to
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Mr. Sarkaria
H. No. 213-16A
Chandigarh-17
India

Dear Mr. Sarkaria:

Your analysis of the problem arrived, and I have read it through. It appears to be entirely correct. It is excellent work. First let me make a few comments about your propositions.

Your first theorem can be deduced as a corollary of a theorem in my book on fibre bundles called "the covering homotopy theorem." You should work out the details of this application by determining the bundle over the base space S^2 that is involved. When you read the proof of the covering homotopy theorem you will recognize your own arguments in a more general setting.

Using obstruction theory in an elementary way, try to prove the following proposition: If X is a complex (possibly with a countably infinite number of cells) of some finite dimension k, and if $H^i(X) = 0$ for $n \leq i \leq k$, then every mapping from X to S^n is inessential.

Also try: If X is a countable complex of dimension $\leq k$, and $H^i(X) = 0$ for $n < i \leq k$, then to each $e \in H^n(X)$ corresponds a mapping of X in S^n of degree e.

In your letter you speak of studying algebraic topology systematically. This type of study is good but only in moderate amounts; when carried to excess it produces indigestion. Roughly half of your studies should be based on interests and enthusiasms of the moment. A way to sustain such interest is to keep a list of problems whose formulations you understand, and that have some depth.

Now let me turn to the matter of advising you on where to apply for graduate studies. There is a crucial question that you will need to answer for yourself: Will you aim for a career as an applied mathematician, or as a full-time teacher, or as a research mathematician with part-time teaching? The great majority of mathematicians who teach in colleges and universities do no research, and only a small minority carry on significant research. Most of the latter have certain traits in common: an intense curiosity, a self-

confidence bordering on egotism, and a large capacity for tolerating frustration. The need for this last trait is easily explained. The mathematics that one teaches or applies (the mathematics in books) is all beautifully and satisfactorily arranged; a love for such mathematics does not make a research mathematician. He must live with disorganized facts imbedded in a sea of mud. He must expend much fruitless effort, and be content with slow progress. The satisfactions gained from doing research are rarely adequate to sustain the effort. Hence, to supply their daily quota of contentment, most researchers depend on other activities such as teaching, sports, games, or music.

If you aim to be a research mathematician, and are especially interested in topology, then you should apply for admission to several of the following: the University of California at Berkeley, the University of Chicago, Massachusetts Institute of Technology, and Princeton University. If your aim is more modest but you would still like to hold onto the possibility of a research type degree in topology, then you might apply to several of: the Courant Institute of New York University, Brown University in Providence, Rhode Island, the University of Michigan, and Cornell University in Ithaca, N. Y.. The two schools where you have applied have no distinction either in topology or in producing good research type doctorates in mathematics. (I sent them recommendations as you requested.)

You should request application forms now. Most schools require that applications for admission next September be completed by the end of January.

Sincerely yours,

Norman E. Steenrod

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