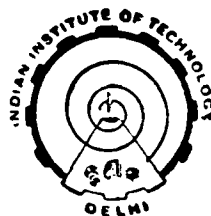


PARAMETRIC INSTABILITIES IN MAGNETIZED PLASMAS

by
ATUL KUMAR

*A Thesis submitted to the
Indian Institute of Technology, Delhi
for the award of the Degree of
DOCTOR OF PHILOSOPHY*

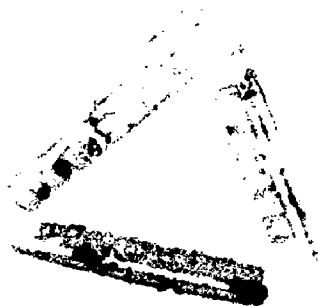


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DECLARATION

I hereby declare that the work, which is being presented in this thesis entitled, "Parametric instabilities in magnetized plasmas" in fulfilment of the requirements for the award of the degree of 'Doctor of Philosophy', submitted in the Centre of Energy Studies, I.I.T., Delhi is an authentic record of the research work carried out by me under the supervision of Dr. R.P.Sharma, Assistant Professor, Centre of Energy Studies, Indian Institute of Technology, Delhi. The matter embodied in this thesis has not been submitted by me or any body else for the award of any other degree.

Atul Kumar

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(Candidate's Signature)

Certification by Supervisor:

This is to be certify that the above statements made by the candidate are correct to the best of my knowledge. I feel satisfied with his work and allow him to submit his thesis.

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DEDICATED
TO
MY PARENTS

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to Dr. R.P.Sharma for his guidance, kind encouragement and invaluable assistance throughout the course of this work, without which the present work would not have been possible. His ever helping and friendly nature kept me relaxed during this period, a vital factor that makes all the difference between success and failure. His availability and everreadiness for discussions made this arduous task possible. No words can truly express my deep sense of gratitude to him.

I take this opportunity to extend my sincere thanks to my colleague Yogesh Kumar Tripathi, for his help and assistance without which my task would have been more difficult. Help and inspiration of various friends and colleagues is acknowledged, who helped me at various stages of present work, particularly to mention the names R.S.Sharma, A.K.Jain, K.Mukherjee, S.S.Verma, A.Laxman, V.K.Rathi and P.K.Sharma.

Perhaps, the credit for the present work largely goes to my parents and a friend Radhey Shyam who, by their continuous inspiration and unflinching loves, never allowed me to look back whenever I seemed to waver.

Finally, it gives me great pleasure in thanking Mr. Anil Khandelwal and Jagdish K. Lohia for his elegant and neat typing of the thesis.

Atul Kumar

(ATUL KUMAR)

SUMMARY

In the present thesis, author discusses various parametric instabilities which might be important during radio frequency heating of the magnetically confined plasmas. Some of these investigations may be useful for explaining the magnetic pulsation phenomenon as well as the existence of some new modes in the earth's magnetosphere.

In the first two chapters, the parametric decay instability of extraordinary electromagnetic (em) wave into a high frequency wave (either electron Bernstein wave or quasilongitudinal right handed circularly polarised waves) and a low frequency electron acoustic wave has been examined in a plasma having ion temperature greater than electron temperature. Application of this investigation is pointed out for TMX-U (tandem mirror) and space plasmas. For example, for TMX-U parameters in the thermal barrier region the growth time of the instability comes out to $\approx 0.07 \mu\text{sec}$ at a pump power flux of $\approx 10 \text{ W/cm}^2$ for the decay channel involving electron Bernstein wave as a high frequency wave. In addition to this, parametric decay instability of extraordinary em wave into magnetized electron plasma and whistler waves has also been examined in the third chapter. Applications of these investigations have been pointed out to tokamak and mirror devices as well as in space plasmas. For example: For the tandem mirror

parameters in the thermal barrier region the convective threshold comes out to be 100 W/cm^2 .

In tokamaks, fast waves (whistler) have also been used for current drive purposes as an alternative candidate because the prospects of lower hybrid current drive are bleak because of density limit. However, when the power of the fast wave is sufficiently high it may undergo parametric decay, therefore, it may be a potential energy loss channel. In the fourth chapter some possible parametric decay channels of fast wave (whistler) have been examined and applications are pointed out to tokamaks, TMX-U (tandem mirrors) and space plasmas. For example, the convective threshold for the decay channel involving lower hybrid and kinetic-Alfvén waves comes out to be 3 kW/cm^2 for JIPPT-II-U parameters.

As an alternative mode to the fast wave, the ion-Bernstein wave is also being used for supplementary heating. The parametric decay and oscillating two stream instabilities of ion-Bernstein waves have been examined in the last chapter of the present thesis. Application of this investigation is pointed out to tokamak devices. It has been seen that the threshold power for the parametric process comes out to be comparable or even less than the nonlinear ion Landau damping process for JIPPT-II-U parameters. Therefore, this parametric process may be viewed as one of the possible source of ion heating.

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