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Convective Boundary Layers in Porous Media: External Flows

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I. INTRODUCTION

During the last five decades buoyancy-driven flow through porous media has been the subject of many investigations. This is due to its many practical applications which can be modeled or approximated as transport phenomena in porous media, e.g., geothermal energy extraction, storage of nuclear waste material, groundwater flows, industrial and agricultural water distribution, oil recovery processes, thermal insulation engineering, pollutant dispersion in aquifers, cooling of electronic components, packed-bed reactors, food processing, casting and welding of manufacturing processes, the dispersion of chemical contaminants in various processes in the chemical industry and in the environment, to name just a few applications. This topic is of vital importance to these systems, thereby generating the need for a full understanding of transport processes through porous media. Comprehensive literature surveys concerning these processes can be found in the most recent books by Ingham and Pop (1998) and Nield and Bejan (1999), with reference to the review articles included therein.

Prandtl's (1904) boundary-layer theory proved to be of vital importance in Newtonian fluids as the Navier–Stokes equations can be converted into much simpler equations which are easier to handle. In the 1960s, with the increase of technological importance of transport phenomena through porous media, similar attempts were made by Wooding (1963) to solve

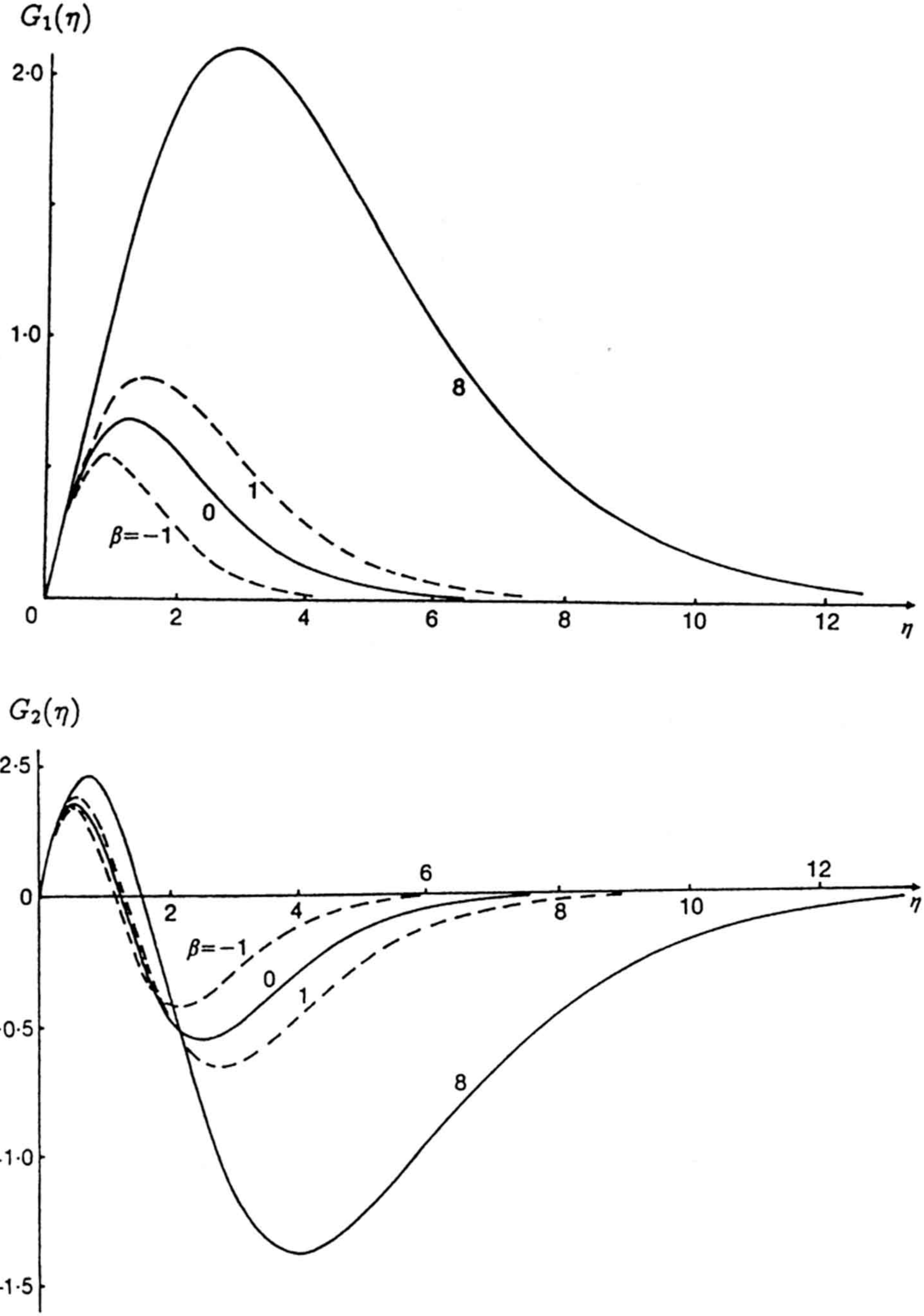

Figure 2. Profiles of the first (a) and second (b) eigensolutions obtained from the numerical integration of Eqs. (21).