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RELOCATABLE SOAP-II SUBROUTINE FOR FINDING CLEBSCH-GORDAN COEFFICIENTS

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ABSTRACT

An outline of the nature and use of a subroutine for computing Clebsch-Gordan coefficients has been written for the IBM-650 Augmented Data Processing System. Some familiarity with IBM's Symbolic Optimal Assembly Program (SOAP) is assumed.

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INTRODUCTION

This subroutine, given five independent variables, A, B, C, β, γ, will compute the Clebsch-Gordan coefficient:[1]

$$C_{\alpha,\beta,\gamma}^{A,B,C} = \sqrt{\frac{(A+B-C)!\,(C+A-B)!\,(C+B-A)!\,(2C+1)\,(A+\alpha)!\,(A-\alpha)!\,(B+\beta)!\,(B-\beta)!\,(C+\gamma)!\,(C-\gamma)!}{(A+B+C+1)!}}$$

$$\cdot \sum_k \frac{(-1)^k}{k!\,(A+B-C-k)!\,(A-\alpha-k)!\,(B+\beta-k)!\,(C-B+\alpha+k)!\,(C-A-\beta+k)!},$$

where k takes all integral values that give nonnegative factorials, and α is a function of β and γ.

LOCATION

The subroutine, RACA, together with an incorporated square-root subroutine, occupies 324 memory locations. The square-root subroutine (standard 650 floating-point) must be relocated at first-word-address (FWA) of RACA + 218 by the operator. Its entrance address will be FWA of RACA + 282, and it may be used for any square roots occurring in the operator's program, as well as being used by RACA.

ENTRANCE

RACA is programmed as a standard subroutine, i.e., an exit command is stored in the distributor by the user, and then control is transferred to the entrance of the subroutine. For any relocation the entrance is FWA + 11, or, symbolically, **RACA**.

The user must store the five independent variables A, B, C, β, γ (in 650 floating-point notation) before entering **RACA** as follows:

$$A \rightarrow FWA + 1$$
$$B \rightarrow FWA + 2$$
$$C \rightarrow FWA + 3$$
$$\beta \rightarrow FWA + 5$$
$$\gamma \rightarrow FWA + 6.$$

The subroutine will compute α.

If the subroutine is left at 0000 or relocated by a multiple of 50, the five independent variables will turn out to be in a read band, which means the input can come directly from cards. This is convenient when it is simply desired to produce some arbitrary sequence of Clebsch-Gordan coefficients.

OUTPUT

The subroutine places the answer, $C_{\alpha,\beta,\gamma}^{A,B,C,}$, in floating-point notation in the upper accumulator and transfers control to the exit command previously located in FWA + 14.

There are nine conditions that the variables, $A, B, C, \alpha, \beta, \gamma$, must satisfy in order to obtain a meaningful coefficient. These have been given an arbitrary numbering as follows:

Condition	n
$A+B+C+1$ is an integer	1
$C+\gamma$ is an integer	2
$B+\beta$ is an integer	3
$A+B-C \geq 0$	4

$A-B+C \geq 0$	5
$-A+B+C \geq 0$	6
$C-\lvert\gamma\rvert \geq 0$	7
$B-\lvert\beta\rvert \geq 0$	8
$A-\lvert\alpha\rvert \geq 0$.	9

When one of these is violated, the subroutine places zero in the upper accumulator, and a stop command, 01 000n 0195, in the lower. If the user wishes to know the type of violation that has occurred, he may do so by (1) setting the console to stop at the 01 command or (2) programming a check for zero in the lower.

LIMITATIONS

Because floating-point notation is used, one may expect only about seven and one-half significant figures in the output.

Factorials are tabulated up to $25!$, which puts an upper limit on $A+B+C+1$. Minor program revisions could extend this range, if necessary. Copies of the program are available to anyone interested.

ACKNOWLEDGMENT

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FOOTNOTE

[1]Cf. Albert Simon, "Numerical Table of the Clebsch-Gordan Coefficients", ORNL-1718, July 13, 1954, p. 4, paragraph 13.