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THE PROGRAM ORTOCARTAN - NOW AVAILABLE ON ATARI

(Abstract for the workshop A6(ii))

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ORTOCARTAN was first announced in 1979 and has been around ever since (see contributions by this author to the GR9, GR10 and GR11 proceedings). In 1992, it was rewritten into a newer version of Cambridge LISP and is now available on the personal computers Atari Mega ST. Only about 250 kbytes of core are needed to load the program together with LISP, but a hard disk is an essential convenience. At the time of writing this abstract, a new edition of the user's manual is being prepared.

The program calculates the Ricci rotation coefficients + the tetrad components of the Riemann, Ricci and Weyl tensors from a given orthonormal tetrad of Cartan forms representing the metric. On special request by the user the program will calculate in addition the metric tensor, the Christoffel symbols, the Einstein tensor + the coordinate components of the Riemann, Ricci, Weyl and Einstein tensors, with arbitrary positions of indices. It uses a rather efficient algorithm for algebraic simplification and for substitutions what makes it possible to handle quite complicated calculations with a minimal effort of the user and without much introductory training.

A novel and perhaps unique feature of the program is the possibility to perform substitutions by pattern-matching (the concept has been known for many years, but, judging by the published information, most if not all working systems avoid making it accessible to the users). The user can define a special class of variables called MARKERS (suppose M is one of them) which are then used to define whole classes of substitutions. For example, let E be a small parameter whose powers higher than the 1st should be neglected. Normally, one would have to write all the equations $E^2 = 0$, $E^3 = 0$, ..., $E^n = 0$ (up to the highest power that can appear in the course of calculation) explicitly in the list of substitutions. With MARKERS, it is enough to write $E^M = 0$.

The program has no problems with differentiating composite functions (i.e. functions whose arguments are other functions, to an arbitrary depth). A convenience which is sometimes essential is that each substitution is automatically followed by algebraic simplification. In this way, when a series of substitutions is performed, the user is guaranteed to have the next substitution performed exactly in the expression he has seen before (this is not necessarily the case when the simplification is delayed until all the replacements are done - such a design is implemented in some other systems).

To give the readers an idea about the power of the program: ORTOCARTAN can verify that the Ricci tensor of the Kerr solution is zero in approx. 3 minutes (this does not include, of course, the time it has taken to assemble the list of substitutions, 2 pages long in this case).

The main program described above is distributed together with a small "abacus" program CALCULATE that can perform algebraic operations on single expressions given by the user. It can be useful e.g. for differentiation, performing series of substitutions in a given expression or for verifying solutions to differential equations.