NATIONAL SCIENCE FOUNDATION

PROPOSAL EVALUATION FORM

NSF Form 1B (9-81)
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PROPOSAL NO.	INSTITUTION	PLEASE RETURN BY
MCS-8400204	DREXEL UNIVERSITY	

PRINCIPAL INVESTIGATOR	NSF PROGRAM
ZEILBERGER DORON	ALGEBRA AND NUMBER THEORY

TITLE

MATHEMATICAL SCIENCES: PROVING IDENTITIES BY COMBINATORIAL METHODS

FEB 10 1984

COMMENTS (QUALITY OF THE PROPOSED RESEARCH, RECENT RESEARCH ACHIEVEMENTS OF THE PRINCIPAL INVESTIGATOR(S), ETC.) CONTINUE ON ADDITIONAL SHEET(S) AS NECESSARY.

Doron Zeilberger's treatment of the Dyson-Andrews conjecture is very impressive, and rumors have it that the minor errors have been fixed by David Bressoud. In connection with the parenthetical remark on page 5, the referee was correct that "it is extremely unlikely that he (Zeilberger) will solve such a very hard problem in a year". What the referee did not know is that Zeilberger had already been working on this problem for four years. See page 0.1 of the second preprint enclosed with this proposal. However many years it took, it does not matter. What matters is that he had a good idea about how to attack the problem, and essentially carried out all the details.

The Macdonald conjectures were thought to be much harder, since they did not have as many degrees of freedom. However it is not clear that the extra freedom was used in an essential way by Zeilberger, so he should be encouraged to consider these other problems and conjectures.

OVERALL RATING: ☐ EXCELLENT ☒ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

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MATHEMATICAL SCIENCES: PROVING IDENTITIES BY COMBINATORIAL METHODS

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Zeilberger has a reputation as one with brilliant ideas but no patience for details. I wish he would at least be courteous enough to reviewers to proofread his NSF proposal, which contains many misprints.

Zeilberger's proof of Andrews' "q-Dyson conjecture" (with gaps filled in by David Bressoud) caused a minor sensation. Many top level mathematicians had been trying since 1975 to find a proof with analytic tools. The "q-Dyson conjecture" itself has no important applications that I've seen. Nonetheless it is extremely interesting and quite deep. Zeilberger's idea of using tournaments may well lead to proofs of other outstanding conjectures, such as those of Askey and Macdonald. Even if this weren't the case, I would recommend highest priority for support. (Should someone who just proved the Riemann Hypothesis be denied support if it were felt that he was unlikely to progress further?)

OVERALL RATING: ☒ EXCELLENT ☐ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

Verbatim but anonymous copies of reviews will be sent only to the principal investigator/project director. Subject to this NSF policy and applicable laws, including the Freedom of Information Act, 5 USC 552 and formal requests from Chairpersons of Congressional committees having responsibility for NSF, reviewers' comments will be given maximum protection from disclosure.

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ATHEMATICAL SCIENCES: PROVING IDENTITIES BY COMBINATORIAL METHODS

FEB 7 1984

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D.Zeilberger proposes to prove a conjecture of I.G.Macdonald on reduced root systems, generalizing one aspect of a conjecture of George Andrews. The latter was proved by the proposer using a combinatorial method. The proposed research topic is interesting and ~~and~~ worth investigating.

The proposal itself, however, despite (of) its arrogance appearance, is light in substance. Except mentioning some analogs in the language of root system (of) certain combinatorial terminologies used in his proof of Andrews'conjecture, Zeilberger failed to explain the idea and the method in his proof of Andrews'conjecture, nor did he give any reasons why his techniques should work in solving Macdonald's conjecture. A poor proposal. Nevertheless, the investigator seems to be active in recents years.

OVERALL RATING: ☐ EXCELLENT ☐ VERY GOOD ☒ GOOD ☐ FAIR ☐ POOR

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Zeilberger's recent solution of George Andrews' q-Dyson conjecture is highly original and very impressive. Zeilberger's synthesis of his difference equation approach in [17] and direct combinatorial approach in [20] is brilliant (see his publication list). Of the large number of people working on this problem Zeilberger was the only one using direct, elementary combinatorial methods. Zeilberger's solution of the q-Dyson conjecture is very important since his work now provides many deep examples (previously conjectured) of transformations and summation theorems for multiple basic and ordinary hypergeometric series.

In addition to his proof of the q-Dyson conjecture, Zeilberger has made other striking and original combinatorial discoveries. For example, he discovered the main ideas and basic algorithms in his bijective proof of the hook length formula (see [19]). Essentially, Zeilberger's best work is contained in [17, 19, 20, 35] of his publication list.

Though brief and not well-developed, Zeilberger's description of how he hopes to solve the Macdonald conjectures is fundamentally sound. There is a very good chance that his solution of the q-Dyson conjecture will generalize, but Zeilberger must deal with many tricky and technically difficult combinatorial properties of root systems. Nonetheless, in his work in [17, 19, 20, 35] Zeilberger has clearly demonstrated a substantial amount of cleverness, persistence, and energy. Furthermore, in much of this work, he has shown a talent for quickly learning and then effectively using previous ideas of others. All of these strengths will be important in his proposed work on the Macdonald conjectures.

We now do comparisions: Zeilberger deserves full credit for his solution of the q-Dyson conjecture. No one else was trying the same type of approach. K. Kadell's analytic methods were elementary but quite different, and everyone else's approach was much more abstract and/or technical. Very recently, "A Proof of Andrews' q-Dyson Conjecture" by D. Zeilberger and D. Bressoud appeared as a Penn. State Math. Dept. Research Report. Except for the last few pages of the last section, this paper is almost identical with Zeilberger's [35]. Using basic lemmas Zeilberger had already proven earlier in his paper, Bressoud simplified some of the analysis in these last few pages and replaced the rest by a very pretty combinatorial argument (cancelling involutions). Bressoud's work filled some minor holds in this part of the paper. Bressoud's contributions made this part of Zeilberger's paper more elegant, precise,

OVERALL RATING: ☒ EXCELLENT ☐ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

easy to follow.

Now, _____ is deeper and broader than Zeilberger but because of his work in _____ Zeilberger compares very favorably with _____ Moreover, because of the significance and depth of _____ Zeilberger now rates higher than _____ _____ is still very good.

Because of his demonstrated talent and plausible approach to the Macdonald conjectures I strongly recommend that this excellent proposal be funded for two years as requested.

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RECEIVED FEB 8 1984

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Zeilberger has recently proved Andrews's q-analogue of Dyson's conjecture, which was one of the outstanding problems in the theory of basic hypergeometric series. That his proof was essentially combinatorial rather than analytic testifies both to the power of combinatorial methods and to his skill at using them. Zeilberger's many publications show proficiency in a wide range of topics in enumerative combinatorics and identities, with particular mastery of the bijective proof. (My only complaint with his work is that some of his papers are not as carefully written as they should be. For example, there are numerous typographical errors in his proposal, and his name is spelled wrong in the summary proposal budget.) His proposal to apply his method to Macdonald's conjectures (not MacDonald's) is likely to prove fruitful and should be supported.

VERALL RATING: ☒ EXCELLENT ☐ VERY GOOD ☐ GOOD ☐ FAIR ☐ POOR

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