COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 04-2

FOR NSF USE ONLY

NSF PROPOSAL NUMBER

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

AST - STELLAR ASTRONOMY & ASTROPHYSC

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	DUNS# (Data Universal Numbering System)	FILE LOCATION
				102805942	

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

SHOW PREVIOUS AWARD NO. IF THIS IS
☐ A RENEWAL
☐ AN ACCOMPLISHMENT-BASED RENEWAL

0093060

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ☐ NO ☐ IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

Lowell Observatory

AWARDEE ORGANIZATION CODE (IF KNOWN)

4004685000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

Lowell Observatory
1400 W. Mars Hill Road
Flagstaff, AZ. 86001

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

PERFORMING ORGANIZATION CODE (IF KNOWN)

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING 9 DIGIT ZIP CODE

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS
☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **The Evolution of Massive Stars as a Function of Metallicity: Closing the Loop Observationally in the Local Group**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **26,426**	**6** months		

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.A)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date _____
☐ HUMAN SUBJECTS (GPG II.D.6)
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.g.(iv).(c))
_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD DEPARTMENT

PI/PD POSTAL ADDRESS
1400 W. Mars Hill Road

Flagstaff, AZ 86001
United States

PI/PD FAX NUMBER
928-774-6296

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Philip L Massey**	**PhD**	**1980**	**928-774-3358**	**massey@lowell.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 04-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☐

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Appendix D of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

SUPPLEMENTAL REQUEST SUMMARY

As part of the work carried out under AST0093060, the PI and collaborators have discovered a potentially serious problem with the effective temperature scale of red supergiants (RSGs). Although not part of the original work, resolving this is necessary to meet many of the scientific goals of the project, as an accurate knowledge of this scale is needed in order to place stars on the H-R diagram. Fortunately a new generation of stellar atmosphere models is now available through collaborator Bertrand Plez. The PI has applied these to new spectrophotometry obtained of Galactic RSGs, finding excellent agreement between the model fluxes **and** TiO band strengths with the dereddened data. The resulting effective temperature scale for Galactic RSGs is approximately 400 K hotter (12%) for the later M supergiants. This translates to over a 1 mag difference in the inferred luminosities of these stars, greatly revising the results of previous comparisons of the number of RSGs of a given luminosity with other massive stars, as well as comparisons with stellar evolutionary models.

This supplemental request is aimed at extending this work to RSGs in the Magellanic Clouds. The Magellanic Clouds are of considerably lower metallicity environment, and hence understanding the RSG effective temperature scale is necessary if the project is going to be successful in tracking the relative number of massive stars as a function of metallicity among the galaxies of the Local Group, one of the key scientific goals stated in the original proposal. Five nights have already been assigned for this project on the Cerro Tololo 4-m telescope in late November, and the supplement will provide travel support for the PI as well as for Emily Levesque, a junior at MIT, who has been involved in the recalibration of the Galactic RSGs. In addition, support is sought for for 6 weeks of the PI's salary and for publication costs. In terms of broader impact, the supplement will allow the continued participation of Ms Levesque in the project; women have traditionally been unrepresented in the physical sciences.

SUPPLEMENTAL REQUEST JUSTIFICATION

I am requesting a supplement to my NSF grant AST-0093060 ("The evolution of Massive Stars as a Function of Metallicity: Closing the Loop Observationally in the Local Group"). The NSF generously funded this at the full level ($235,453 over 3 years) and as shown in my previous progress reports, I have completed much of the work described. There have been six refereed first-authored publications, and two invited reviews at conferences, with an additional three papers in the works and covered under the original funding. In terms of broader impact, this research has included undergraduates Shadrian Holmes (now a graduate student at the Univ. of Texas), and Wayne Schlingman (about to enter graduate school at the Univ. of Arizona), both members of groups that have traditionally been underrepresented in the physical sciences (Holmes: female; Schlingman: self-described Hispanic).

One of the very interesting, but unanticipated, results of these studies to date have concerned red supergiants (RSGs), a short-lived but important stage in the life of a massive stars. At the time I submitted the original proposal, we knew that stellar evolution models failed to reproduce the relative number of RSGs and Wolf-Rayet stars. Was this due deficiencies in the evolutionary models, or observational incompleteness? Under the auspices of the grant, we identified potential red supergiant candidates in the Magellanic Clouds from a broad-band CCD survey (Massey 2002, ApJS, 141, 81), and obtained follow-up spectroscopy at Tololo with the 4-m (Massey & Olsen 2003, AJ, 126, 2886). These studies revealed that the number of RSGs had indeed been poorly known (while the number of WRs was about right; see Massey & Duffy 2001, ApJ, 550, 713), but even so there was a serious mismatch between the evolutionary tracks and the "observed" location of RSGs in the H-R diagram.

However, in the course of these studies we realized that there was a serious problem with the assumed effective temperature scale of RSGs used to make such comparisons. Although addressing this was not originally part of the originally proposed work, it clearly necessary if we are to meet the scientific goals, as it is impossible to place the RSGs in the H-R diagram (for comparison with other massive stars or the evolutionary tracks) in a meaningful way without an accurate knowledge of the effective temperature of these stars. This is particularly true given the sensitivity of the bolometric correction to effective temperature for stars this cool.

We have begun to address this by comparing new spectrophotometry of Galactic RSGs with the MARCs stellar atmosphere models computed by collaborator Bertran Plez (Univ Montpellier II, France). These models are the first to include a proper treatment of molecules (including TiO) and thus allow for the first time a comparison between the actual line depths of the principle classification lines and the models. We show the results of the fit for one such Galactic star in Fig. 1. Although there are some systematic differences below 4200Å, in general there is excellent agreement between the models and the observations for both the line strengths and the dereddened continuum fluxes. Using this technique we have just obtained a new calibration of the effective temperature scale of Galactic RSGs (Fig. 2). For the later M-type supergiants, the scale is about 400 K warmer than that previously assumed. **This translates to over a 1 mag change in the adopted bolometric luminosity for the later M supergiants.** This has a significant effect on comparisons of the location of RSGs both with the evolutionary models, and for determining the relative number of RSGs above a certain luminosity threshold with that of other massive stars.

We are asking for supplemental funding to now apply the same technique to red supergiants in the Magellanic Clouds. Because of the lower metallicity in the SMC (one-quarter solar) and LMC (one-half solar) we would expect a star of the same effective temperature to have less TiO in its spectrum, and hence be classified as an earlier type in the Clouds. Indeed, Massey & Olsen (2003) found that there was a significance difference in the distri-

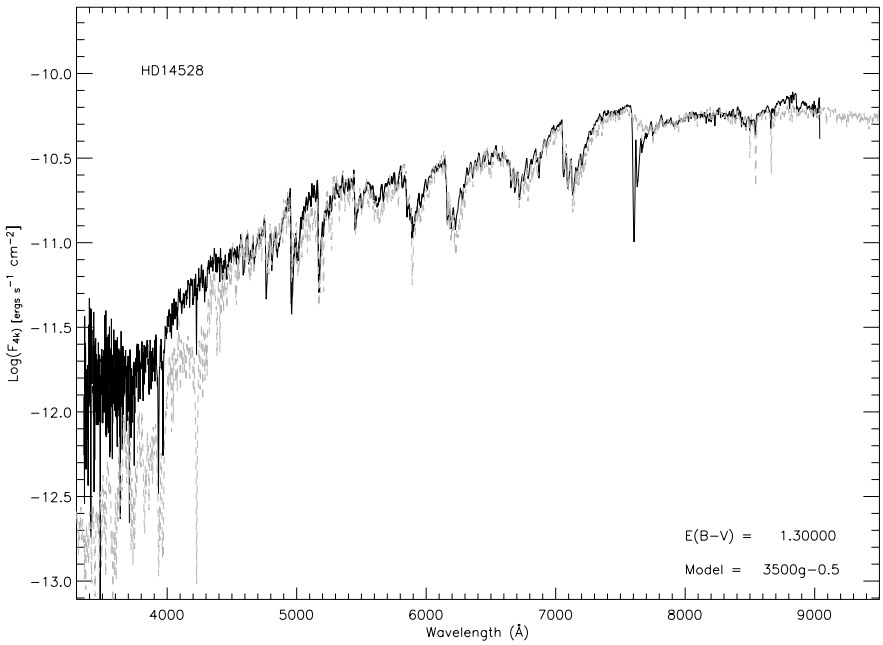

Figure 1: The spectrum of HD 14528, a Galactic M4 I star (solid curve) is shown compared to the $\log g = -0.5$, $T_{\rm eff} = 3500$ K, $Z = 1.0$ MARCs model (dashed curve). There is excellent agreement between the dereddened flux of the star, and the strengths of the prominent TiO features. This comparison also shows that the models have somewhat too high opacity in the region < 4200Å, a matter which is under investigation by collaborator Plez.

bution of spectral types of RSGs in the SMC and LMC and compared to the Milky Way, with a progression in average spectral type from K5 I (SMC) to M1 I (LMC) to M2-3 I (MW). But, we also expect that stars of a given mass may not evolve in the same way due to the lessened effects of mass-loss at lower metallicity. By obtaining spectrophotometry of the Magellanic Cloud RSGs we previously identified, and comparing these to low metallicity MARCs models, we can determine the effective temperature scale of SMC and LMC red supergiants in the same manner that we have done for the Galactic stars. This is necessary if we are to make meaningful comparisons between the number of red supergiants and other massive stars as a function of metallicity, and to make comparisons between the distribution of RSGs and the evolutionary models in other Local Group galaxies, as we had originally proposed.

We have been fortunate enough to obtain 5 nights on the CTIO 4-m for this project in late November and early December. The supplement will cover travel support for the PI and undergraduate Emily Levesque (MIT), who has been involved in the Galactic part of the study through her participation in the REU program this summer. In addition, it will cover 6 weeks of the PI's salary for the data collection, analysis, and writing the paper, as well as the publication costs. An extension of 6 months, to June 2005, is also requested in order to complete this work and publication.

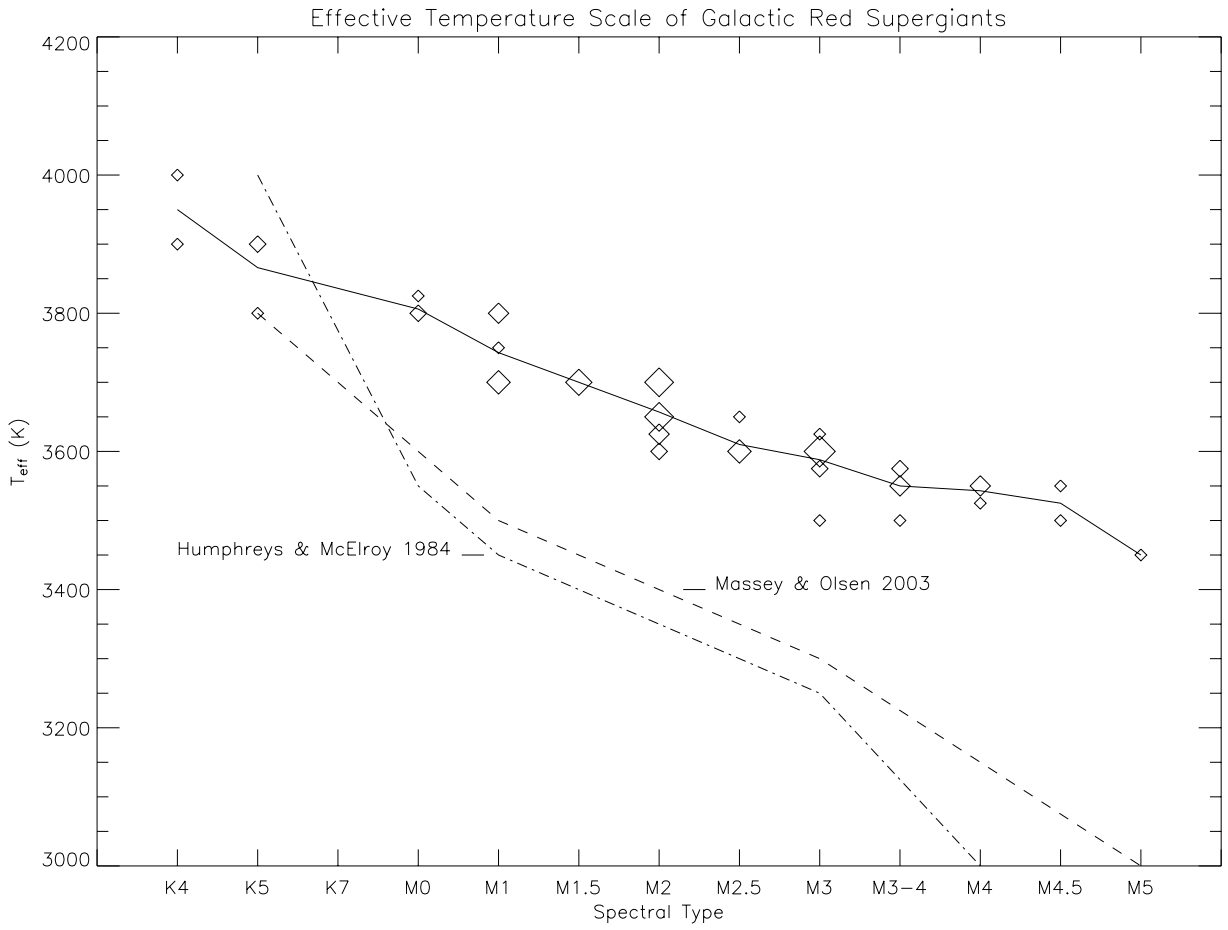

Figure 2: The effective temperatures of Galactic RSGs is shown as a function of spectral type by the diamonds; the size of the symbol is proportional to the square root of the number of data at a particular point. The solid line shows our new effective temperature scale. This is significantly hotter than previous assumed calibrations, such as that adopted by Massey & Olsen (2003) or Humphreys & McElroy (1984).

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Lowell Observatory**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Philip L Massey**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Philip L Massey - none**	1.50	0.00	0.00	$ 10,650	$
2.					
3.					
4.					
5.					
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	0	
7. (1) TOTAL SENIOR PERSONNEL (1 - 6)	1.50	0.00	0.00	10,650	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	0	
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	0	
3. (0) GRADUATE STUDENTS				0	
4. (1) UNDERGRADUATE STUDENTS				0	
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				0	
6. (0) OTHER				0	
TOTAL SALARIES AND WAGES (A + B)				10,650	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				2,236	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				12,886	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				0	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				0	
2. FOREIGN				3,000	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ 0					
2. TRAVEL 0					
3. SUBSISTENCE 1,000					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (2) TOTAL PARTICIPANT COSTS				1,000	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				0	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				1,800	
3. CONSULTANT SERVICES				0	
4. COMPUTER SERVICES				0	
5. SUBAWARDS				0	
6. OTHER				0	
TOTAL OTHER DIRECT COSTS				1,800	
H. TOTAL DIRECT COSTS (A THROUGH G)				18,686	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **Overhead (Rate: 72.6800, Base: 10650)**					
TOTAL INDIRECT COSTS (F&A)				7,740	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				26,426	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				0	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ 26,426	$

M. COST SHARING PROPOSED LEVEL $ 0 AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Philip L Massey**

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **Lowell Observatory**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Philip L Massey**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Philip L Massey - none**	**1.50**	**0.00**	**0.00**	$ **10,650**	$
2.					
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**1**) TOTAL SENIOR PERSONNEL (1 - 6)	**1.50**	**0.00**	**0.00**	**10,650**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**0.00**	**0.00**	**0.00**	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**1**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**10,650**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**2,236**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**12,886**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**3,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **1,000**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**2**) TOTAL PARTICIPANT COSTS				**1,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**1,800**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**1,800**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**18,686**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**7,740**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**26,426**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **26,426**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Philip L Massey**

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification Page

The budget includes an additional 6 weeks of salary for the PI (Massey), travel to Chile for the PI and undergraduate Emily Levesque (MIT), support at CTIO for 5 nights of observing for both the PI and Ms Levesque, and page charges. The details are summarized below:

A. Senior Personnel Salaries: Six weeks of salary is requested for the PI. This time includes observing in Chile (1 week), plus time to reduce and analyze the data (3 weeks) plus time to prepare the paper for publication (2 weeks).

C. Fringe Benefits: At Lowell, fringe benefits are estimated at 21% of salaries; actual will be charged.

E. Travel: We have budgeted for one trip to Chile for observing on the CTIO 4-m (scheduled Nov 23-Dec 3). We estimate the airfare as $1500 each for Massey and Levesque.

F. Participants Support Costs: We have budgeted for lodging and meals on CTIO for 5 nights at $100/day/person for Massey and Levesque.

G. Other Direct Costs: We have budged for one ApJ paper, 15 pages at $120/page.

I. Indirect Costs: Lowell's indirect cost is computed on the basis of 72.68% of salaries only. The current rate was authorized by the Defense Contract Audit Agency (DCAA) dated 8/22/02. The Cognizant Agency is the ONR, San diego Office.

GROUPE DE RECHERCHE EN ASTRONOMIE ET ASTROPHYSIQUE
DU LANGUEDOC

UNITÉ MIXTE DE RECHERCHE UMII-CNRS

to whom it may concern

Dr. Phil Massey has applied for observing time to secure accurate spectrophotometry of red supergiant stars. I and my co-workers here in Montpellier, and in Sweden (the group of Prof. B. Gustafsson), are extremely interested by such data, and I am therefore co-I of this application, together with my colleague Dr. E. Josselin. We are building a new generation of MARCS stellar model atmospheres, not yet publicly available, especially suited for cool stars, including the best up-to-date atomic and molecular opacities, chemical equilibrium, and a very detailed account of radiative transfer.
The proposed observations together with our models will first allow the definition of a temperature scale at solar and subsolar metallicity for red supergiants, and simultaneously permit a detailed check of the model spectra. We then plan further studies of these objects, which are still poorly known despite their high intrinsic luminosity, and their importance for stellar and galactic evolution.
This collaboration will ensure a maximum scientific output through a direct close collaboration between observers and modelers.

Prof. Bertrand Plez
Montpellier, September 29, 2003

UNIVERSITÉ MONTPELLIER II

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Mél: plez@graal.univ-montp2.fr