APOGEE-2S External Observations

Overview

Carnegie's scientific staff, or members of the Chilean astronomical community, may obtain observations with the APOGEE-2S spectrograph using nights approved and/or assigned by the Carnegie Time Allocation Committee. Procedures and parameters for conducting such 'external' APOGEE-2S observing programs are outlined below, along with a high-level summary of the design and anticipated performance of the APOGEE-2S spectrograph on the du Pont telescope.

Please refer all questions about APOGEE-2S external observations to one or more of:

- Jeff Crane (crane "at" obs "dot" carnegiescience "dot" edu)
- Ricardo Munoz (kleineameise2 "at" gmail "dot" com), APOGEE-2S Survey Operations Scientist
- Kevin Covey (kevin.covey *at* wwu *dot* edu), APOGEE-2 Special Targets Coordinator
- Steve Majewski (srm4n *at* virginia *dot* edu), APOGEE-2 PI
- Jennifer Sobeck (jss7qg *at* virginia *dot* edu), APOGEE-2 Deputy Project Manager

Key Procedures & Parameters for non-SDSS-IV Observations with APOGEE-2S

Eligibility: Carnegie's scientific staff, including astronomers, postdoctoral fellows and postdoctoral associates in any Carnegie department or employed at Las Campanas Observatory, may apply to the Carnegie Time Allocation Committee for nights to use APOGEE-2S for their personal scientific research programs. Carnegie may also assign nights for programs approved by the Chilean National Time Allocation Committee (CNTAC).

Scheduling: External programs will be allocated and scheduled on a per-night (not per-plate or per-fiber) basis. Currently, the Carnegie TAC can allocate up to 25 nights per year for external APOGEE-2S observations. Carnegie/CNTAC programs will be allocated specific nights, typically on either end of a main SDSS/APOGEE-2 scheduling block so that the SDSS-IV and Carnegie programs maintain clearly separated distributions of lunation and risks of potential loss of observing time due to weather or technical problems. The Carnegie TAC will coordinate the night-by-night scheduling of APOGEE-2S external observations with SDSS-IV to assure that APOGEE-2S operations can be supported on the assigned nights.

Observing Procedures: All marking, plugging, and observations for external APOGEE-2S programs will be executed by the SDSS-IV plugging and observing staff to maintain the safety and integrity of the APOGEE-2S instrument and infrastructure. All programs must follow basic instrumental limits (i.e., 47" minimum separation between fibers, and no targets within 62" of the plate center), and absent specific instructions directing otherwise, plates will be designed following typical APOGEE protocols (i.e., using 15 telluric + 35 sky fibers, and filling unused fibers with targets meeting the standard APOGEE-2 target selection criteria).

External Program Entries in the SDSS-IV Project Database: Approved External Programs will, when submitting target files to SDSS-IV, enter a program title and list of PI/Co-Is into the SDSS-IV Project Announcement system. The system will have a specific category for such projects; the submitted information will be available to SDSS-IV collaboration members, but is not required to be distributed via the SDSS-IV mailing lists. More detailed information about the external program (equivalent to the usual level of detail for a SDSS project announcement) will be made available to the SDSS-IV Executive MC (Director, Project Scientist, Program Manager, and Spokesperson) and the APOGEE-2 PI. This additional information will be kept proprietary.

First year operations: External programs starting within a year after the first successful APOGEE-2S observations will only be accepted if they provide targets that conform to the standards of the APOGEE-2S target selection database & plate design systems, and if the plates can be observed in an identical manner to APOGEE-2S survey plates, without alterations to operations procedures or

software. For more on the format required for APOGEE-2 target/plate files, see https://trac.sdss.org/wiki/APOGEE2/SpecialTargetSubmission.

Targeting & Program Documentation: External programs must submit target information to SDSS-IV at least six months in advance of the planned observations to allow time for plate preparation and integration of the planned nights into the main APOGEE-2S operations plan. Target information will include documentation of the program itself and of all the individual types of targets, for use in the eventual public SDSS-IV/APOGEE-2 data release; for examples of the level of this documentation, see documentation for ancillary programs conducted in SDSS-III, presented in the appendix of the DR12 paper http://adsabs.harvard.edu/abs/2015ApJS..219...12A and on the DR12 webpage for APOGEE Ancillary Science Programs http://www.sdss.org/dr12/algorithms/ancillary/apogee/.

Data Processing: Data will be fully processed through all standard APOGEE-2 pipelines on a best-effort basis, with data products made available by the same means as APOGEE-2 program data. Current expectations are that processed and combined spectra will be available approx. 6 months after external observations are taken (see full schedule below).

External Program Participants & Authorship: External programs are not committed to the SDSS-IV project and publication policies. Participation in and authorship on papers that use data obtained by external programs will be at the discretion of the principal investigator for each external observation program. Projects combining external observations and proprietary SDSS-IV data, however, must adhere to SDSS-IV policies governing the use of proprietary survey data.

Program Costs: SDSS-IV will invoice Carnegie $400 US (2015 dollars) for each APOGEE-2S plate designed & drilled for external programs. These costs may then be passed on directly to program PIs. The $400/plate charge will be waived, however, for programs that opt for non-proprietary 'contributed data' status.

Proprietary Period: Data obtained by external programs will be considered proprietary to the principal investigator of each program for a period of one year from the date the standard APOGEE reductions are made available. After that time they may be released publicly as part of the SDSS-IV data archive. Except by the consent of the external observation principal investigator, they may not be used by members of the SDSS-IV collaboration until that time. Prior to its public release, the status of the raw and reduced data as proprietary will be made clear in SDSS-IV's internal data distribution and documentation. Projects combining external observations and proprietary SDSS-IV data, however, must adhere to SDSS-IV policies governing the use of proprietary survey data.

Contributed data: External program PIs may choose to contribute their data to the SDSS-IV, with the agreement of the program PI, the SDSS-IV director and the Carnegie TAC. SDSS-IV will not charge the PIs any of the marginal costs of the plates or operations for such 'contributed programs'. Data from contributed programs would be available to the SDSS-IV collaboration on the same basis as other APOGEE-2S survey data (i.e., the proprietary period will be waived, and standard SDSS-IV project and publication policies apply to the use of such data, including the requirement to announce the project to the full SDSS-IV collaboration).

Expected Schedule for Implementation of APOGEE-2S External Programs

As APOGEE-2S observations are not yet underway, we cannot yet provide an experience-validated timeline for the various steps involved in the APOGEE-2S plate design, observation, and reduction process. The schedule below provides our current best guess as to the timeline for ensuring that plate designs proposed in 2016 or later can be completed and delivered to LCO in time to perform the desired observations, as well as the amount of time that will be needed to produce the desired data products for the proposing PI. This timeline will be updated once APOGEE-2S observations have become routine, and more reliable time estimates can be provided. Until that time, the schedule below remains tentative, and subject to change as circumstances require.

- PI submits proposal to CNTAC / Carnegie TAC: ~9+ months (mid-April for observations during following calendar year)
- schedule for plates/fields to be observed over the course of each night submitted to targeting team for vetting: 6 months before observations
- special observing coordinator examines proposed night schedule to determine if it is compatible with APOGEE-2S operational model, and if not, suggests changes: 5.5 months before

observations
- PI provides detailed target lists to southern targeting team: 5 months before observations.
- southern targeting team processes target lists, informs PIs if any targets are lost due to collisions, what telluric standards are, etc: 4 months before observations
- final plate designs released for drilling after iterations with primary science team: 3 months before observations
- plates shipped to LCO: 2 months before observations
- observations conducted.
- pipeline spectra reductions available to external PI: ~3 months after observations conducted
- ASPCAP reductions available to external PI: ~6 months after observations conducted

Design Considerations for APOGEE-2S Observations

The APOGEE-2S spectrograph is limited to 300 fibers per plug plate: typically 250 fibers are placed on science targets, with the remaining 50 fibers divided between 15 standard stars (e.g., early type stars for telluric absorption correction) and 35 fibers allocated to blank sky locations for measuring atmospheric emission (predominantly OH emission lines). The APOGEE-2S instrument is designed to deliver a FOV of 2.1 degrees in diameter, with fibers providing an angular diameter of 1.3" arc seconds. The collision limit for APOGEE-2S fibers is 56 arc-seconds; fibers cannot be placed on two targets closer than this distance on a single APOGEE-2S plate. Similarly, a central support post prevents observations of targets within 62.5 arc seconds of the center of an APOGEE-2S field. **Proposed external APOGEE-2S targets must be able to satisfy these hard constraints on APOGEE-2S target selection and field design.**

The throughput and expected S/N characteristics of the APOGEE-2S are not yet known, but will be expected to be similar to those delivered by the APOGEE-2N system. Typical S/N values achieved by APOGEE-2N are tabulated below as a function of target magnitude and exposure time (expressed in units of 1 hour visits, APOGEE's typical observing mode).

H band magnitude	# of 1 hr. visits	Typical S/N per resolution element
11.3	1	100
12.2	1	45
13.3	1	20
14.2	1	10
12	3	100
13.3	3	40
14.4	3	20
11.9	12	200
13	12	100
14.3	12	40
15	12	28

Note that APOGEE-2N spectra appear to exhibit a S/N ceiling of ~200, likely due to systematic effects related to sky subtraction, telluric correction and persistence in the APOGEE-2N detectors. The bright limit for all APOGEE-2N plates is H = 7, and for at least the first year of APOGEE-2S operations, this bright limit will apply to all APOGEE-2S observations as well. The faint limit for standard APOGEE-2N/2S fields typically corresponds to the magnitude required to acheive a target S/N = 100 -- this limit is as bright as H ~ 11 for single-visit fields, and as faint as H ~ 14 in a field with 24 visits. External observations can target objects fainter than the H=11-14 magnitude limits, but users must be aware that such targets will be observed to a lower S/N and will not necessarily yield a full parameter/abundance extraction from the standard APOGEE pipeline (see Data Reduction & Analysis Pipelines Section for more on typical uncertainties for delivered parameters).

APOGEE targeting procedures place strong constraints on cross-fiber contamination in the spectrograph focal plane and rely on a simple fiber management scheme to limit large magnitude differences between adjacent spectra as well as a general limit of no more than a 5? magnitude H-band spread allowed for targets on the same plate. Target lists having sources spanning large, but strongly non-uniform magnitude distributions may lead to the spectra of faint sources being strongly

affected by contamination from brighter, adjacent sources: proposers who are concerned about potential inter-fiber contamination are encouraged to contact Kevin Covey (kevin.covey@wwu.edu), the APOGEE special projects coordinator, to investigate the impact that inter-fiber contamination may have on their proposed observations.

APOGEE-2S Data Reduction & Analysis Pipelines

The APOGEE-2S data reduction and analysis pipelines are optimized for the processing of G, K, and early-M giant stars, and are not guaranteed to work for other types of targets. These pipelines aim to deliver a number of data products, principally: (1) extracted spectra with first-order corrections for airglow emission, telluric absorption, and instrumental response; (2) radial velocities; (3) stellar parameters (e.g., Teff, log g, [Fe/H]); and (4) elemental abundances. Currently the pipeline provides stellar parameters (e.g. Teff, log g, [Fe/H] and radial velocities) as well as individual elemental abundances (e.g, C, N, O, Na, Mg, Al, Si, S, K, Ca, Ti, V, Mn, Fe, and Ni) for all giants with 3500 < Teff < 5000 K. Uncertainties on these parameters are a complex function of source properties as well as S/N; typical benchmark precisions for giants with T_eff ~ 4500, [Fe/H] ~ 0 and S/N ~ 100 spectra are ~75K in T_eff, ~0.2 dex in [Fe/H], and ~0.2 km/sec in RV. No special considerations will be made in the APOGEE reduction pipeline for APOGEE-2S external observations science, but stellar targets that do not depart substantially from the optimal range of stellar parameters will in general be run through current version of the stellar parameter/abundance analysis pipeline (ASPCAP). Though proposers may wish to depend on ASPCAP to derive parameters for stars of appropriate type, external APOGEE-2S proposers are ultimately responsible for any additional data reduction beyond the nominal APOGEE-2S reduction pipeline. Details on the APOGEE-2S reduction and analysis pipelines can be found in the published DR10 http://adsabs.harvard.edu/abs/2014ApJS..211...17A, DR12 http://adsabs.harvard.edu/abs/2015ApJS..219...12A and APOGEE-1 data reduction http://adsabs.harvard.edu/abs/2015arXiv150103742N and data products http://adsabs.harvard.edu/abs/2015arXiv150104110H papers.

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