Mark Yashar
Curriculum Vitae

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E-mail: mark.yashar@gmail.com
Cell Phone: (530)-574-1834
LinkedIn Profile: http://www.linkedin.com/in/markyashar
Github Profile: https://github.com/markyashar

EMPLOYMENT/RESEARCH OBJECTIVES AND INTERESTS

- To obtain a research or related computing position in or near the larger San Francisco Bay Area, California involving technical, scientific, and/or computer skills in the physical sciences, including physics (astrophysics/cosmology), space and earth sciences, and planetary science. Willing to acquire new computational and theoretical skills as needed.
- Interested in the utilization and development of modeling, data analysis, statistical, mining, reduction, and processing algorithms, methods, and techniques in a wide range of possible physical science, computational science, and engineering disciplines.
- Additional interests: astronomical techniques, scientific computing/computational science, data science, image processing, modeling, numerical methods, data visualization, software development.

EDUCATION

Ph.D. Physics, 12/2008 , Supervisor: Dr. Andreas Albrecht, UC Davis
Doctoral Thesis: "Topics in Microlensing and Dark Energy"
M.S. Physics, 01/1999, San Francisco State University, San Francisco, CA
B.A. Physics (concentration Astronomy), 05/1994, San Francisco State University

PROFESSIONAL DEVELOPMENT

09/2016-10/2016
Introduction to Data Science with Python: 6-week course, **Metis**, San Francisco, CA.
Course Instructors: Ramesh Sampath (ramesh@sampathweb.com) and TJ Bay (spintronic@gmail.com). Please see https://github.com/markyashar/sf16_ids1/ and my Linkedin profile for further details.

COMPUTER/SOFTWARE SKILLS

- Operating Systems: **Windows**, **Linux (Red Hat, Centos, Ubuntu)**, **Unix**, **Mac OS**.
- Programming Languages and Data Analysis Packages: **Python** (including **numpy**, **matplotlib, scipy,** and **scikit-learn** libraries), **C/C++** (including object-oriented programming and associated use of **gdb** and **ddd** debuggers and **Eclipse**), **MATLAB/Octave**, **Fortran**, **Perl, R,** Unix shell scripting**, IDL, Java, Mathematica, HTML, Berkeley DB XML, MySQL,** Common Astronomy Software Applications (**CASA**), **IRAF**, **MeqTrees, Weather Research and Forecasting (WRF) Model, WRF-Cem, Ferret, NCAR Command Language (NCL), NetCDF Command line Operators (NCO)**.
- Other Software Applications: **LaTex**, **EXCEL** (including use of formulas, functions, and plotting features and capabilies), Concurrent Version Systems (**CVS), VMware Workstation**, **Liferay Enterprise**.
- **High Performance Computing** (e.g., **Cray** XE6)**, Hadoop, MapReduce**.

SCIENTIFIC/TECHNICAL SKILLS

- Monte Carlo methods and techniques
- Markov Chain Monte Carlo (**MCMC**) (including Bayesian analysis)
- Machine Learning
- Data, signal, and image processing and analysis; error analysis and statistics
- Data visualization
- Numerical modeling, simulation
- Scientific/technical writing

EMPLOYMENT AND RESEARCH EXPERIENCE

- 03/16-08/16: **Business Analyst,** Visa Checkout Fraud Analysis (Temporary contract position). Supervisor: T. Pan (Visa, Inc.)
- 02/12-02/14: **Postdoctoral Scholar-Employee,** Meteorological and CO_2 Regional Modeling. Supervisor: I. Fung (UCB)
- 02/09-02/12: **Postdoctoral Research Associate**, SKA research and development. Supervisor: A. Kemball (UIUC)
- 05/06 -12/08 : **Research Asst.,** Dark Energy research. Supervisor: A. Albrecht (UCD)
- 01/04-01/06: **Research Asst.,** MACHO research project. Supervisor: K. Cook (LLNL)
- 09/02-05/03: **Research Asst**., TEXES data processing. Supervisor: M. Richter (UCD)
- 08/99-08/01: **Data Aide,** USA data processing and handling. Supervisor: P. Kunz (SLAC)
- 9/01-12/08: **Reader/T.A.** Supervisors: W. Potter, L. Lubin, D. Webb (UCD)

REFERENCES

Prof. Inez Fung, Earth & Planetary Science, UCB, (510)-643-9367, ifung@berkeley.edu
Prof. Andreas Albrecht, Physics, UCD, (530)-754-9269, albrecht@physics.ucdavis.edu
Prof. Athol Kemball, Astronomy/NCSA, UIUC, (217)-333-7898, akemball@illinois.edu
David Elvins, Earth & Planetary Science, UCB,(510)-643-8336, elvins@berkeley.edu
Prof. Chris Fassnacht, Physics, UCD, (530)-554-2600, fassnacht@physics.ucdavis.edu
Tina Pan, Visa Inc. Digital Operations, (415)-225-4388, tpan@visa.com

EMPLOYMENT AND RESEARCH EXPERIENCE – more details

03/2016-08/2016
Business Analyst (temporary contractor position)**,** Visa Inc. Digital Operations, Foster City, California (CA)
Supervisor: Tina Pan(tpan@visa.com), Director of Fraud Operations, Visa Inc. Digital Operations

- Visa Checkout fraud research and analysis
- Weekly fraud monitoring (including extensive use of **EXCEL**)
- Python code analysis

02/2012-02/2014
Earth and Planetary Science Department, University of California, Berkeley
Postdoctoral Scholar-Employee. Research focused on mesoscale and regional atmospheric (forward or "bottom-up") modeling and analysis of anthropogenic and biogenic carbon dioxide tracer emissions, flux, and concentrations in northern California. This work has included extensive use of the Weather Research & Forecasting Model (WRF) and the WRF-Chem coupled weather-air quality model for atmospheric transport simulations.

Supervisor: Prof. Inez Fung, UCB

02/2009-02/2012
National Center for Supercomputing Applications, University of Illinois Urbana-Champaign
Postdoctoral Research Associate. Research and development in Square Kilometer Array calibration and processing algorithms and computing with a focus on cost and feasibility studies of radio imaging algorithms (involving extensive use of **Python**). Memo: "Computational Costs of Radio Imaging Algorithms Dealing with the Non-Coplanar Baselines Effect: I" with A. Kemball (http://www.astro.kemball.net/Publish/files/ska_tdp_memos/cpg_memo3_v1.1.pdf).
Supervisor: Dr. Athol Kemball, UIUC

05/2006 – 12/2008
University of California, Davis
Research Assistant. Carried out a Markov Chain Monte Carlo analysis and exploration of a quintessence dark energy model (with use of **Matlab**) under the direction of Prof. Andreas Albrecht. Also wrote, modified and submitted batch job scripts to run Matlab MCMC code on a Linux computing cluster. Published Paper: "Exploring Parameter Constraints on Quintessential Dark Energy: the Inverse Power Law Model," with B. Bozek, A. Albrecht, A. Abrahamse, and M. Barnard.
Supervisor: Professor Andreas Albrecht, UC Davis

01/2004 – 01/2006
University of California, Davis / Lawrence Livermore National Laboratory
Research Assistant and Participating Guest. Assisted Dr. Kem Cook with research, modeling, and data analysis for the Massive Halo Compact Object (MACHO) project. Assisted in the development of reddening models to constrain locations of micro-lensing source stars and possible lensing objects (MACHOs) in the Large Magellanic Cloud (LMC) and halo of the Milky Way Galaxy.
Supervisor: Dr. Kem Cook, LLNL

09/2002-05/2003
University of California, Davis
Research Assistant. Assisted in processing data of spectra of stars and circumstellar material obtained by the Texas Echelon Cross Echelle Spectrograph (TEXES) for the mid-infrared used with the NASA Infrared Telescope Facility. Data extraction and processing was carried out using Fortran and **IDL**.
Supervisor: Dr. Matt Richter, UC Davis

09/2002 – 12/2008
University of California, Davis
Reader, held office hours, and proctored exams for undergraduate and graduate physics courses including classical mechanics, electricity and magnetism, mathematical methods in physics, astrophysics, introductory astronomy and cosmology, and quantum mechanics. Specific examples:

Astronomy 25 (Introduction to Astronomy), Physics 153 (Extragalactic Astrophysics), Physics 9D (Modern Physics), Physics 127 (Cosmology), Astronomy 10G (Introduction to Astronomy), Physics 110C (Electricity and Magnetism), Physics 105A and B (Classical Mechanics)
Supervisors: Dr. Wendell Potter, Lori Lubin, David Webb, UC Davis

9/2001-12/2001
University of California, Davis
Teaching Assistant. Assisted in supervising a Physics 7A (Introductory Physics) Discussion/Lab course.

Supervisor: Dr. Wendell Potter, UC Davis

8/1999 – 8/2001
Stanford Linear Accelerator Center
Menlo Park, CA
Data Aide for Group K (Particle Astrophysics). Data handling, processing, and archive maintenance on the USA (Unconventional Stellar Aspect) experiment at SLAC. This work included downloading data files from the Naval Research Laboratory (in Washington, D.C.) and processing them to create FITS files for scientist's use locally. Wrote and assisted in writing and developing **Perl** and UNIX shell scripts for the purpose of automating and expediting many of the data handling, processing, and archive maintenance tasks and for submitting batch jobs to Linux computing clusters at SLAC. Some Windows NT support, maintenance, and Desktop administration.
Supervisors: Dr. Paul Kunz, Professor Elliott Bloom.

01/1999-06/1999
Department of Physics and Astronomy, San Francisco State University, CA
Student Project. Engaged in laboratory project for astronomy lab course instructed by Dr. Adrienne Cool in which possible cataclysmic variable star candidates were identified in Hubble Space Telescope images of the globular star cluster NGC 6397 using **IRAF** and SAOTNG software packages. Also carried out observational project on variable stars for this course using a 10-inch Epoch Telescope-CCD system and the IRAF and SAOTNG software packages.

JOURNAL PUBLICATIONS
Exploring Parameter Constraints on Quintessential Dark Energy: The Inverse Power Law Model, **Yashar, M**., Bozek, B, Albrecht, A., Abrahamse, A., Barnard, M.
2009, Physical Review D, 79, 103004

A *measure of the impact of future dark energy experiments based on discriminating power among quintessence models*, Barnard, M., Abrahamse, A., Albrecht, A., Bozek, B, **Yashar, M.**
2008, Physical Review D,78, 043528; 2009, Physical Review D, 80, 129903(E).

Exploring Parameter Constraints on Quintessential Dark Energy: the Albrecht-Skordis model,
Barnard, M., Abrahamse, A., Albrecht, A., Bozek, B, **Yashar, M.**
2008, Physical Review D, 77, 103502

OTHER PUBLICATIONS
Doctoral Thesis: *Topics in Microlensing and Dark Energy,* **Yashar, M.**, December 2008.

Computational Costs of Radio Imaging Algorithms Dealing with the Non-coplanar Baselines Effect: I, **Yashar, M**., Kemball, A., 2010
TDP Calibration and Processing Group Memo #3
(http://www.astro.kemball.net/Publish/files/ska_tdp_memos/cpg_memo3_v1.1.pdf)

Calibration and Processing Constraints on Antenna and Feed Designs for the SKA: I, Kemball, A., Cornwell, T., **Yashar, M. ,** 2009
TDP Calibration and Processing Group Memo #4
(http://www.astro.kemball.net/Publish/files/ska_tdp_memos/CP_Antenna_Feed.pdf)

GRANTS AND SUPPORTED RESEARCH ASSOCIATESHIPS
National Science Foundation Grant (02/2009-02/2012, A. Kemball); Department of Energy (2007, A. Albrecht; 2012, I. Fung) and National Science Foundation (2004, K. Cook, R. Becker) research funds.

PROFESSIONAL AFFILIATIONS/MEMBERSHIPS
American Physical Society
American Geophysical Union

WORKSHOPS AND CONFERENCE PARTICIPATION
American Geophysical Union Fall Meeting
Moscone Center, San Francisco, CA
December 9-13, 2013

Basic WRF Winter Tutorial
National Center for Atmospheric Research (NCAR), Boulder, CO
January 28 – February 1, 2013

MET WRF Tutorial
NCAR, Boulder, CO
February 4-5, 2013

SKA Calibration and Processing F2F Group Meeting
Hyatt Regency O'Hare Hotel, Chicago, IL
January 15, 2010

5th Annual Cosmology in Northern California (CINC '08)
Kavli Institute for Particle Astrophysics and Cosmology (KIPAC)
Stanford Linear Accelerator Center. 18 April, 2008

4th Annual Cosmology in Northern California (CINC '07)
University of California, Davis. 11 May, 2007

Cosmo 2006 International Workshop on Particle
Physics and the Early Universe, Granlibakken Conference Center
and Resort, Tahoe City. 24 - 29 September, 2006.

RESEARCH EXPERIENCE – additional details
Meteorological and CO_2 Regional Modeling.
02/2012-02/2014
University of California, Berkeley
Research focused on mesoscale and regional (forward or "bottom-up") atmospheric transport modeling and analysis of anthropogenic and biogenic carbon dioxide emissions from northern California for multi-scale estimation and quantification of atmospheric CO2 concentrations. This work has included extensive use of the Weather Research & Forecasting Model (written mostly in **FORTRAN**), the WRF-Chem coupled weather-air quality model for atmospheric transport simulations, and the Vegetation Photosynthesis and Respiration Model (WRF-VPRM) biospheric model to simulate CO_2 biosphere fluxes and atmospheric CO_2 concentrations. One area of focus of this work was to study and gain a better understanding of what effect diurnal varying/cycled CO2 fluxes had on simulated CO2 concentrations as compared to time-invariant CO2 flux emissions and as a way to assess source and/or sink sampling bias..]

I also installed, compiled, built, and configured WRF, WRF-Chem, and VPRM on the NERSC

multi-core supercomputing system "Hopper" and submitted batch job scripts to this system to run the WRF model simulations. In addition to the use of WRF, this work also involved the use of the **R statistical scripting language**, the **NCAR Command Language (NCL)**, **Matlab**, **Python,** and **Ferret** (http://ferret.pmel.noaa.gov/Ferret/home) for additional pre- and post-processing, modification, and visualization of netCDF files. For additional details and information, please see **http://www.linkedin.com/in/markyashar**.
Supervisor: Professor Inez Fung, UCB

Square Kilometer Array processing and development
02/2009-02/2012
National Center for Supercomputing Applications, University of Illinois Urbana-Champaign
Research and development in Square Kilometer Array calibration and processing algorithms and computing with a focus on cost and feasibility studies of radio imaging algorithms and direction-dependent calibration errors with the Technology Development Project (TDP) Calibration Processing Group (CPG) at UIUC (http://rai.ncsa.uiuc.edu/SKA/RAI_Projects_SKA_CPG.html). This work has included an evaluation of the computational costs of non-deconvolved images of a number of existing radio interferometry algorithms used to deal with non-coplanar baselines in wide-field radio interferometry (Memo: "Computational Costs of Radio Imaging Algorithms Dealing with the Non-Coplanar Baselines Effect: I" with A. Kemball (http://www.astro.kemball.net/Publish/files/ska_tdp_memos/cpg_memo3_v1.1.pdf)) [1]. My work with the SKA project has also involved extensive use of **Python** and **C++** and the use and implementation of numerical and imaging simulations in conjunction with the use of the **Meqtrees** software package (http://www.astron.nl/meqwiki) and the **CASA** software package to address cost, feasibility, dynamic range, and image fidelity issues related to calibration and processing for SKA and the dependence of these issues on certain key antenna and feed design parameters such as sidelobe level and mount type. Numerical simulations have included Monte Carlo simulations (written in Python) to test equations derived in [12].
Supervisor: Professor Athol Kemball, UIUC

Dark Energy research
05/2006 – 12/2008
University of California, Davis
Due to a great deal of confusion in the theoretical domain, the field of cosmic acceleration (i.e., dark energy) is highly data driven at this stage, and there are a number of exciting new and proposed observational programs that could have a great impact on the field. As a graduate student, I worked on a research project with Professor Andreas Albrecht's research group that involved an MCMC analysis of a dark energy quintessence model (known as the Inverse Power Law (IPL) or Ratra-Peebles model [2,3,4]) that included the utilization of Dark Energy Task Force data models that simulated current and future data sets from such new and proposed observational programs [5]. Following the approach taken by the DETF we generated "data models" for future SNe Ia, BAO, weak gravitational lensing, and CMB observations as a representation of future dark energy experiments. We generated simulated data sets for a Lambda-CDM background cosmology as well as a case where the dark energy was provided by a specific IPL model. Following the approach taken by [6,7,8], we then used an MCMC algorithm to map the likelihood around each fiducial model via a Markov chain of points in parameter space, starting with the fiducial model and moving to a succession of random points in space using a Metropolis-Hastings stepping algorithm. From the associated likelihood contours, we found that the respective increase in constraining power with higher quality data sets produced by our analysis gave results that were broadly consistent with the DETF for the dark energy parameterization that they used. We also found, consistent with the findings of [6,7,8], that for a universe containing dark energy described by the IPL potential, a cosmological constant can be excluded by high quality "Stage 4" experiments by well over 3 sigma [9]. (Published in Phys. Rev. D: "Exploring Parameter Constraints on Quintessential Dark Energy: the Inverse Power Law Model," with B. Bozek, A. Albrecht, A. Abrahamse, and M. Barnard.)
Supervisor: Professor Andreas Albrecht, UCD

MACHO research project
01/2004 – 01/2006
University of California, Davis / Lawrence Livermore National Laboratory
I engaged in a research project with Dr. Kem Cook at LLNL that expands and extends the work of [10] and involved the utilization and development of reddening models, star formation histories, color magnitude diagrams (CMDs), and microlensing population models of the Large Magellanic cloud to constrain the locations of micro-lensing source stars and micro-lensing objects (MACHOs) in the Large Magellanic Cloud (LMC) and the Milky Way halo using data of 13 microlensing source stars obtained by the MACHO collaboration with the Hubble Space Telescope. We attempted to distinguish between source stars drawn from the average population of the LMC and source stars drawn from a population behind the LMC by examining the HST CMD of microlensing source stars and comparing it to the average LMC population. We carried out a 2-dimensional Kolmogorov-Smirnoff (KS) test to quantify the probability that the observed microlensing source stars are drawn from a specific model population. The 13 event KS-test analysis results rule out a model in which the source stars all belong to some background population at a confidence level of 99%. The results of the KS test analysis, taken together with external constraints, also suggested that the most likely explanation is that the lens population comes mainly from the MW halo and the source stars are located in the LMC disk and/or bar. The strength of this analysis was severely limited by the number of microlensing events used, but other ongoing microlensing surveys and projects could provide a sufficient sample of microlensing events over the next few years. The technique outlined here could prove a powerful method for locating source stars and lenses with the use of these future data sets.

Past and ongoing (and potential future) work has also included a more sophisticated analysis of the MACHO source stars in relation to the general LMC population by deriving the underlying un-reddened stellar CMD and then constructing various reddening models involving uniform reddening as well as Poisson reddening models with a Poisson distribution of "cloudlets" (to make a detailed study of the effect of patchiness on the significance of the KS test) for the populations supplying the microlensing source stars, and, thus, recreating any populations that we are interested in testing. We can then compare these reddened model CMDs and the observed source star CMDs and the microlensing source stars and use the 2-dimesional KS test to determine what model fits the data best. In this way, we can use the data to test whether the null hypothesis that the population of microlensing source stars came from the "normal" CMD fits the data better than if the source stars came from some other "background" distribution of stars. The synthetic CMD algorithm "StarFISH" [11] has been used to generate non-reddened model CMDs. Potential future work could involve the use of other synthetic CMD algorithms and/or updated theoretical isochrones.
Supervisor: Dr. Kem Cook, LLNL

Computational Physics Research project - extrasolar planets and habitable zones
01/2003 - 05/2003
University of California, Davis
For the final project in a graduate level computational physics course instructed by Professor John Rundle, I wrote computer code in **Fortran** and **IDL** (available upon request) briefly described as follows: The program computes a closed orbital ellipse of an extrasolar planet orbiting a single star using data input by the user. The program queries the user to enter various orbital and physical parameters of the planet-star system and uses this data to calculate the observed effective equilibrium blackbody temperature of the extrasolar planet for a given orbital phase. The program also calculates the planet-to-star flux ratios at given orbital phases. Plots are also generated showing the shape and

size of the orbit, orbital speed vs. orbital phase, planet temperature vs. orbital phase, and planet-to-star flux ratios vs. orbital phase. Finally, the code also gives an indication as to whether the inputs entered meet the criteria for a habitable planet.

TEXES data processing
09/2002-05/2003
University of California, Davis
I assisted Dr. Mathew Richter at U.C. Davis in processing data of spectra of stars and circumstellar material obtained by the Texas Echelon Cross Echelle Spectrograph (TEXES) for the mid-infrared used with the NASA Infrared Telescope Facility. Data extraction and processing was carried out using **Fortran**. Spectra were displayed using **IDL**. The project focused on finding water and OH absorption features in the spectra (e.g., flux vs. wave number) of nearby stars possessing possible circumstellar disks. Water absorption features in the Earth's atmosphere were taken into account.
Supervisor: Dr. Mathew Richter, UC Davis

Data Aide, SLAC Particle Astrophysics
08/1999 – 08/2001
Stanford Linear Accelerator Center, Menlo Park, CA
Tasks, Duties, and Responsibilities included:

- Data handling, processing, and archive maintenance on the USA (Unconventional Stellar Aspect) experiment at SLAC. This work included downloading data files from the Naval Research Laboratory (in Washington, D.C.) and processing them to create FITS files for scientist's use locally. The work also included the submission of batch jobs to other computing systems and clusters. I wrote and assisted in writing and developing Perl and UNIX shell scripts for the purpose of automating and expediting many of the data handling, processing, and archive maintenance tasks. I also wrote and copied the raw data files to computer tape cartridges.
- Assisted in scheduling and setting up USA teleconferences.
- Some Windows support, maintenance, and Desktop administration.

(USA was an X-ray timing space-based experiment that was launched on February 23, 1999 on the Advanced Research and Global Observations Satellite (ARGOS). It was designed in part for scientific research in X-ray timing and time resolved spectroscopy of bright galactic X-ray sources)
Supervisors: Paul Kunz, Elliott Bloom

HST data analysis
01/1999-06/1999
Department of Physics and Astronomy, San Francisco State University, CA
I engaged in a laboratory project for an astronomy lab course instructed by Dr. Adrienne Cool in which possible cataclysmic variable (CV) star candidates were identified from light curves and R vs. H-alpha plots using R and H-alpha CCD images taken with the Hubble Space Telescope Wide Field Planetary Camera 2 (WFPC 2) of the central regions of the globular star cluster NGC 6397. **IRAF, SAOTNG** , and Supermongo software packages were used in the analysis.

Three possible CV candidates were first identified by eye by blinking between R and H-alpha images. Two of the three possible CV candidates were verified as “H-alpha bright” as compared to reference stars. A plot of R vs. H-alpha – R for three possible CV candidates plus all the reference stars was then generated from all this data. Two of the candidates stood out as significantly brighter in H-alpha than the reference stars. In order to check if the three possible candidate CVs were actually variable stars, instrumental magnitudes for each of the CV

candidates and two reference stars (for each candidate) were measured for each of the R images in the full set of 13 R images (spanning several hours). Using this data, light curves (instrument magnitude vs. HST orbit number) were obtained for each of the possible CV candidates and reference stars. The light curves of two CV candidates and their respective reference stars, along with calculations of standard deviations, indicated significantly greater scatter and variability in the instrumental magnitudes of the two CV candidates over the course of the 13 observations than for any of the reference stars. The light curves for the two CV candidates also appeared to exhibit a regularity or periodicity in variability of some sort over the course of the 13 observations. All of this information, along with the verification of these objects as standing out as "H-alpha bright" with respect to reference stars, lends support to their status and identification as actual CV candidates. The light curve of another possible CV candidate and its associated reference stars and corresponding calculations of standard deviations also indicated significantly greater scatter or variability of instrumental magnitude over time than for the reference stars. However, the light curve of this possible candidate did not appear to exhibit the same amount of consistent regularity or periodicity as exhibited by the light curves of the other candidates. This information, along with the inability to verify this possible candidate as standing out as significantly brighter in H-alpha than the reference stars, seems to weaken the case for identifying this object as an actual CV candidate.

I also carried out an observational project on variable stars for this astronomy lab course using a 10-inch Epoch Telescope-CCD system and the IRAF and SAOTNG software packages.

References

[1] **M. Yashar** and A. Kemball, "Computational Costs of Radio Imaging Algorithms Dealing with the Non-Coplanar Baselines Effect: I", TDP Calibration and Processing Group Memo 3, 2010, http://www.astro.kemball.net/Publish/files/ska_tdp_memos/cpg_memo3_v1.1.pdf

[2] B. Ratra and P. J. E. Peebles, Phys. Rev. D **37,** 3406 (1988).

[3] P. J. E. Peebles and B. Ratra, Astrophys. J. **325**, L17 (1988).

[4] P. J. E. Peebles and B. Ratra, Rev. Mod. Phys. **75**, 559 (2003).

[5] A. Albrecht et al., astro-ph/0609591.(2006)

[6] M. Barnard et al., Phys. Rev. D **77**, 103502 (2008).

[7] B. Bozek et al., Phys. Rev. D **77**, 103504 (2008)

[8] A. Abrahamse et al., Phys. Rev. D **77**, 103503 (2008).

[9] M. Yashar et al., Physical Review D, **79**, 103004 (2009).

[10] C. Alcock et al. , ApJ, 552, 582 (2001).

[11] J. Harris and D. Zaritsky, ApJS, 136,25 (2001).

[12] A. Kemball, T. Cornwell, and **M. Yashar** "Calibration and Processing Constraints on Antenna and Feed Designs for the SKA: I", TDP Calibration and Processing Group Memo 4, 2009, http://www.astro.kemball.net/Publish/files/ska_tdp_memos/CP_Antenna_Feed.pdf