RFI Excision Research (MRI)

Objective:

Investigate new methods for removing RFI from astronomical data through real-time or post-detection/correlation processing techniques.

Goals:

1. Implement RFI excision devices and software tools for use by users of the GBT, Arecibo, and other existing radio telescopes.
2. Contribute to instrument design with regard to RFI mitigation in the ATA and SKA projects.
3. Communicate results and limitations of RFI excision to spectrum managers for use in frequency allocation negotiations.

Project Management:

Current two-year MRI grant from the NSF has Rick Fisher and Richard Bradley as Co-PIs. They are also Co-PIs with Brian Jeffs and David Arnold of the BYU EE Dept. on an NSF ATI grant to BYU. The MRI is partially funded by matching funds from the SETI Institute to support a UC-Berkeley post-doc and consultancy from Steve Ellingson at OSU. All groups have established a common email forum and various data sharing arrangements. We are currently looking for a half-time Co-op student and a UVA grad student. Rich Bradley may reduce his involvement in this research to devote more time to the beam-forming array. Anish Roshi is also working on this research.

Time Scale:

Two-year MRI but should be continuing research

Funding and Personnel Requirements:

	2001	2002	2003	2004
	$52K	$60K	$5K	$50K
Project Mgmt	0.1	0.1	0.1	0.1
Elec. Engineer	0.5	0.5	0.5	0.5
Elec. Technician	0.5	0.5	0.5	0.5
Mech. Engineer	0.1	0.1	0.1	0.1
Machine Shop	0.3	0.3	0.3	0.3
Software Eng.	0.2	0.2	0.2	0.2
Staff Scientist	0.1	0.1	0.1	0.1
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Totals	2.3	2.3	2.3	2.3

April 2001

MRI

Project Summary

We propose to develop fundamental techniques for the protection of radio astronomy and exobiology search instruments from the effects of interference from ground-based and satellite transmissions. Adaptive signal canceling and null-steering methods will be analyzed and applied to system-noise-limited measurements of very weak cosmic signals. Many of these techniques are known to the sonar, radar, and communications communities, but low interference-to-noise ratio and complete lack of desired waveform information in radio astronomy impose special constraints on adaptive canceling algorithms which have not been necessary in other fields of radio engineering. The work proposed here will be implemented for use with the 100-meter Green Bank Telescope (GBT) (Lockman, 1998), the 305-meter Arecibo dish, and the One Hectare Telescope (1hT) (Dreher, 1999) being developed by the University of California Berkeley and the SETI Institute. The same techniques will be applicable to the upgraded VLA (Perley & Sramek, 1995) and to the development of the Square-Kilometer Array (SKA) (Braun, 1996).

Our proposal has two primary components: interference canceling as applied to single dishes, such as the Green Bank and the Arecibo telescopes, and array null steering as applied to the One Hectare Telescope (1hT), the VLA, and the SKA. The adaptive algorithms for the two applications have much in common so a combined effort makes good sense. In fact, one method for canceling interference in a single dish is to add a small auxiliary antenna to create a spatial null in the antenna's sidelobe pattern in the direction of the interferer. The arrays will also benefit from parametric techniques which rely only on time domain signal correlations rather than a spatial null.

We propose to develop a signal processing system for use on the GBT and at Arecibo to cancel interference at frequencies below 1.7 GHz for the study of highly redshifted neutral hydrogen in external galaxies and for the study of the OH molecule in our own and external galaxies. We will also implement hardware and software on the 1hT for steering array nulls toward the strongest sources of interference in the 1-10 GHz range. The problems that we propose to attack are 1) minimization of the effects of adaptive cancellation on spectral baseline stability, 2) constraint of array beam gain and shape in the null-steering process, 3) pre-detection removal of interference on the basis of *a priori* knowledge of interference signal characteristics, and 4) optimization of interference sampling methods for weak signal cancellation. We have made a start on solving these and related problems (Barnbaum & Bradley, 1998; Bradley & Fisher, 1999), but the higher level of effort provided by this MRI is required to benefit the everyday use of radio telescopes. Extension of our techniques to other frequency ranges and other telescopes will be straightforward.

Radio astronomers are devoting more of their resources to interference control and mitigation and are establishing collaborations with experts in adaptive signal processing. Funds from this MRI will allow us to purchase a state-of-the-art digital signal processing system, support an engineering/radio science graduate student, and provide part-time engineering services for the duration of the grant. The SETI Institute will share the cost of this work. The University of California Berkeley will contribute to the study effort as part of its commitment to the 1hT

project. The engineering research group headed by Steve Ellingson at the Ohio State University will provide consulting services to the NRAO and the SETI Institute. The Co-PI's on this proposal will work closely with the NAIC/Arecibo staff to apply the design to their interference problems, and travel money is budgeted to test prototype devices at the Arecibo telescope.

Budget Justification

Year 1

Graduate Student	12 months	$20,400				
Technician	6 months	18,200				
Engineer	3 months	16,380				
Postdoctoral Fellow	6 months	18,604				
Postdoctoral Fellow	6 months	18,604				
Total Salaries			$92,188			
Fringe Benefits		26,735				
Total Salaries and Fringe Benefits				$118,923		
Consulting Services				$ 23,000		
DSP System		24,000				
Digital Hardware Parts		8,000				
Test Equipment		20,000				
Total Materials and Supplies				$ 52,000		
Travel				$ 7,000		
					NSF	SETI Inst.
Total Year 1				$200,923	$129,923	$ 71,000

Year 2

Graduate Student	12 months	$20,400				
Technician	6 months	18,940				
Engineer	3 months	17,035				
Postdoctoral Fellow	6 months	19,380				
Postdoctoral Fellow	6 months	19,380				
Total Salaries			$95,135			
Fringe Benefits		27,589				
Total Salaries and Fringe Benefits				$122,724		
Consulting Services				$ 23,000		
Digital Hardware Parts		10,000				
R.F. Hardware Parts		40,000				
Test Equipment		10,000				
Total Materials and Supplies				$ 60,000		
Travel				$ 8,000		
					NSF	SETI Inst.
Total Year 2				$213,724	$140,724	$ 73,000

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Budget Justification (continued)

Total for Two Years	**$414,647**	**$270,647**	**$144,000**
Fractional Contribution		**65.3 %**	**34.7 %**