

Spectrum Management, Radio Astronomy



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Atacama Large Millimeter/submillimeter Array

Jansky Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array





Commonalities between OIR and radio

In terms of site protection, the biggest differences between radio and OIR are disappearing:

It is no longer possible to expect to use the radio spectrum everywhere, even dedicated astronomy spectrum





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Radio astronomy is falling back upon a smaller set of ever more remote installations

See my map at <http://tinyurl.com/yrvszk>





<http://tinyurl.com/yrvszk>

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World Radio Telescopes And Rad... ☆
<http://www.nrao.edu/~hlszt/MD.txt>
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- Individual styles
- BTL - Crawford Hill, Art Crawf...
- BTL - Karl Jansky's Field
- NRAO - National Radio Astro...
- NRAO Technology Center (N...
- GBT - Robert C. Byrd Green B...
- LWA1
- LWA-OVRO
- LWA-NA
- LWA-SV
- LWA-HM
- NRAO Array Operations Cent...
- VLA - Very Large Array NM
- VLBA-Brewster WA

Google

Terms





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Many are also OIR sites: Kitt Peak, Mt. Graham, Mauna Kea, La Silla, Atacama, South Pole

Curious that these are in the Americas





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These have proliferated in the past decade:

[http://www.itu.int/pub/publications.aspx?](http://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-RA.2259-2012)

[lang=en&parent=R-REP-RA.2259-2012](http://www.itu.int/pub/publications.aspx?lang=en&parent=R-REP-RA.2259-2012)





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One or two (SKA sites) limit aircraft routes, planes can reflect interfering signals into the telescope





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**Some sites have explicit protections, Radio Quiet Zones
Even remote and 'quiet' sites are subject to cell phone, car radars, satellites ...**





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76 - 81 car radars not proposed to have an off-switch!**





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76 - 81 car radars not proposed to have an off-switch!
Please support Draft Resolution B.4!!!**





Commonalities between OIR and radio

Commonalities stop at the point where radio astronomy engages in SPECTRUM MANAGEMENT





What is spectrum management?

- Spectrum management is the politics of access to the electromagnetic spectrum from 0 – 3000 GHz (∞ –100 μ)
 - The politics largely take place at a UN organ in Geneva (ITU–R) disguised as international diplomacy
- It is very big business, there are far more spectrum managers than astronomers
- A growth area! Full of high–paid full–time professionals
 - Vast cadres of colorless nay–saying technocrats
 - Radio astronomy uniquely uses mostly low–paid part–timers
 - Distinguished by MacBooks and gray beards
 - Three full–timers: 2 x NSF, 1 x CRAF
 - Perhaps 5–7 FTE world–wide in PhD astronomers





Why spectrum management? Because. I

- H I at 21cm and OH at 18cm are ONLY observable because radio astronomers have managed to protect their spectrum
 - Currently struggling to force Iridium to provide usable observing conditions for 1612 MHz OH *in our own band!*
 - German telecom agency revoked Iridium's license (yea!)
 - ECC Decision could affect their European operations





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- H I at 21cm and OH at 18cm are ONLY observable because radio astronomers have managed to protect their spectrum
 - Currently struggling to force Iridium to provide usable observing conditions for 1612 MHz OH *in our own band!*
 - Earlier, OH was obscured by GLONASS (boo)
 - Following protracted negotiations with IUCAF (yea!), GLONASS almost totally left our 1612 MHz OH band
 - GLONASS said “enough!” In 2007 and connived to have themselves exempted from final limits (boo!)
 - Your iPhone has a GLONASS receiver





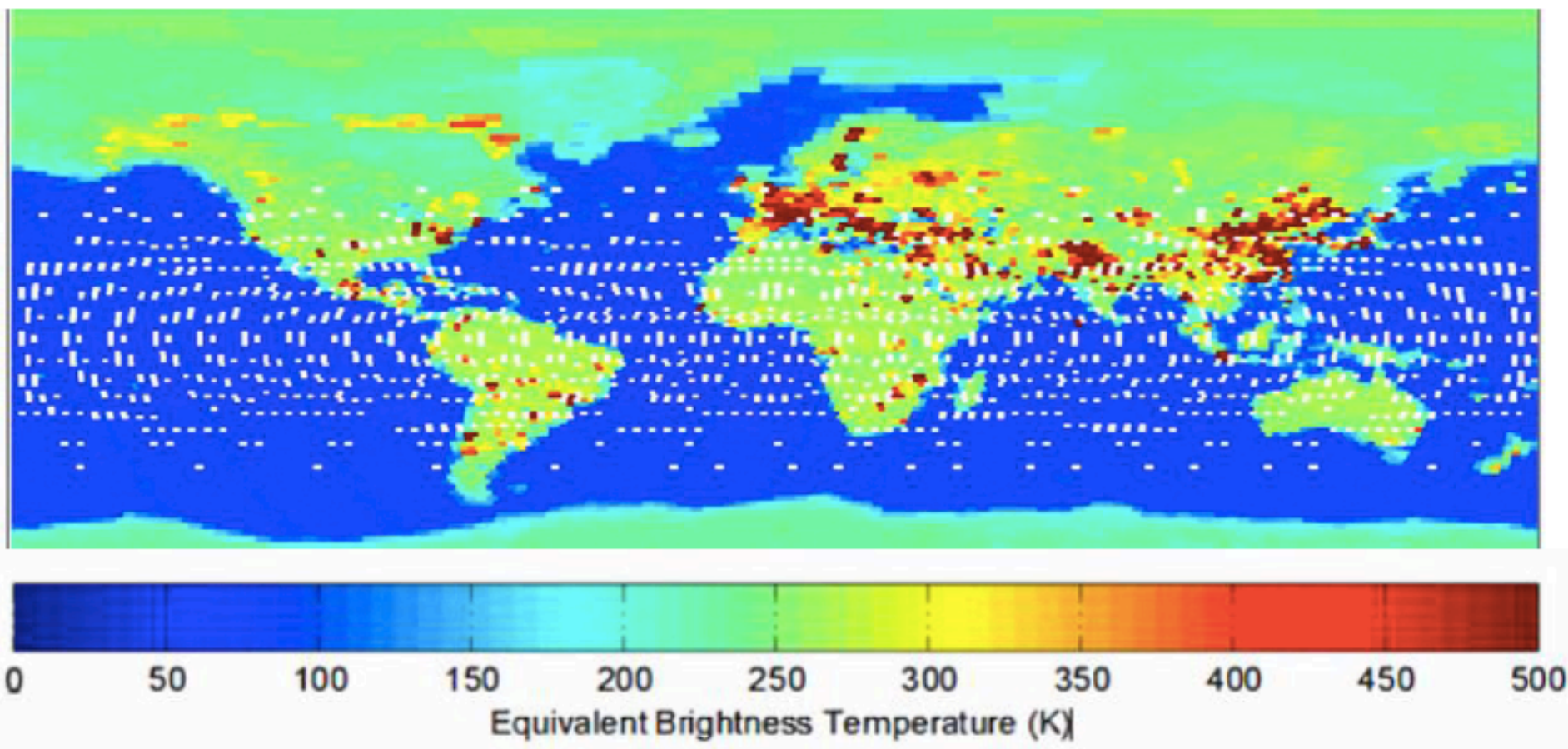
Why spectrum management? Because. II

- H I at 21cm and OH at 18cm are ONLY observable because radio astronomers have managed to protect their spectrum
 - Without care, 21cm H I will have at best only very restricted availability once wireless broadband spectrum is expanded
 - 21cm H I will no longer be available even as a teaching tool without heavy filtering
 - Many administrations are extremely cynical about protecting the 21cm band even though it is used for important soil moisture measurements from space.
 - Are we blowing it by not doing hi-res full-sky surveys while we still have access?





Noise temperature, 1400–1427: RS.2315





Why spectrum management? Because. III

- Transmitters are moving to higher frequencies and broader bandwidths just when our own bandwidths are opening up
 - 9.0–10.5 GHz occupied by orbiting SAR imagers just as the VLA gets complete frequency coverage
 - If a SAR is seen within $\sim 20\text{--}30$ dB of full strength, it's game over for a VLA receiver Or 27 of them.
 - 9.6 GHz SAR operators with white hats just agreed not to illuminate RAS sites without prior notice (yea!)
 - No one will tell me how many SAR are operated by guys with black hats (boo!)
 - Hope to extend coordination to other bands for SAR and the 94 GHz successor to CloudSat





How does spectrum management happen: I

- Parallel but partially overlapping sequences
 - **International allocations** at the ITU-R, the highest level
 - Embodied in the Radio Regulations, a diplomatic treaty
 - Renegotiated and renewed every 3–4 years: WRC–15
 - Harmonization to prevent cross–border interference
 - Standards supposed to promote indiscriminate growth
 - **National allocations** largely track the Radio Regulations
 - Every administration retains sovereignty inside borders
 - Less freedom to differentiate in close quarters
 - Legacy applications impede full harmonization
 - Always a gap in time, US now implementing WRC–07





How does spectrum management happen: II

- Allocations are only the **outline**, the *rules* are the implementation, the details and the devil lives there
 - ITU-R doesn't write the rules, may provide guidelines*
 - **National rules** govern whether our allocations are *usable*
 - Permitted power levels in shared bands
 - Unwanted emission levels for adjacent/nearby bands
 - Limitations on operations in vicinity of radio telescopes
 - Radio quiet and coordination zones

*except in part for satellites





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 - ITU-R doesn't write the rules, may provides guidelines
 - **National rules** govern whether our allocations are *usable*
 - 608 - 614, 1400 - 1427, 2690 - 2700 MHz allocated but unusable in some countries due to their *rules*
 - Fighting for 608 - 614 MHz in US now (boo)
 - FCC announced new rules last Friday but hasn't told anyone what they are (yet) (probably boo)





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 - 608 – 614, 1400 – 1427, 2690 – 2700 MHz allocated but unusable in some countries due to their *rules*
 - Fighting for 608 – 614 MHz in US now
 - Usability of 3–4mm spectrum subject to new radars
 - 7/8 Allocated since 2000 but no rules until now
 - A global struggle to be carried out in the trenches, country by country, but many battles already lost
 - Please vote in favor of Draft Resolution B.4!



Spectrum management bodies for RAS

~5-7 FTE

- Organizations functioning world-wide, regionally, nationally
 - Global: IUCAF <http://www.iucaf.org>
 - Europe, South Africa: CRAF <http://www.craf.eu>
 - CRAF has a full-time PhD astronomer spectrum manager
 - Asia-Pacific: RAFCAP <http://www.atnf.csiro.au/rafcap>
 - US: CORF http://sites.nationalacademies.org/BPA/BPA_048819
 - CORF has volunteer astronomers & legal advice
 - US hires 1-2 PhD astronomers at NSF, unique



What do IUCAF astronomers do all day?

- **IUCAF** (SCIENTIFIC COMMITTEE ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE)
 - Chartered by ICSU – The International Council for Science
 - Adhering bodies are IAU, URSI, COSPAR
 - Provide members (total ~ 12)
 - Together contribute ~ €8K/yr, incidentals/schools
 - » Members are responsible for their expenses
 - Formed to intervene at the ITU’s 1960 WARC
 - Defined “passive service” of radio astronomy
 - Procured the protected band around the 21cm line
 - » In some bands “All emissions are prohibited”
 - » Less obvious than you might think
 - » Always some leakage in from outside





What do IUCAF astronomers do all day?

- **IUCAF** (SCIENTIFIC COMMITTEE ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE)
 - Serves as an umbrella organization, organizing principle
 - Officially recognized as the contact for radio astronomy in several matters concerning satellites
 - Has business meetings at GA of the adhering bodies IAU, URSI and COSPAR
 - Organizes week-long spectrum management schools every 4-5 years: 2000 in US; 2005 in Italy; 2010 in Japan, 2014 in Chile





What do IUCAF astronomers do all day?

- IUCAF (SCIENTIFIC COMMITTEE ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE)
 - Members work within their own administrations to further national and regional policies favorable to astronomy
 - Members formulate consensus IUCAF positions that are articulated at ITU-R in Geneva





What do IUCAF astronomers do all day?

- IUCAF (SCIENTIFIC COMMITTEE ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE)
 - Many members gather in Geneva for Working Party 7D astronomy meetings, twice per year for one week
 - Some attend the very largest plenaries, called CPM-2 (10 days) and WRC (four weeks) every four years
 - Members attend some meetings of non-astronomy groups:
 - I covered meetings of the radar groups WP 5A & 5B and one meeting of a task group charged with identifying new spectrum for IMT- cell phones, wireless broadband
 - Adrian Tiplady and Wim van Driel attended other task group meetings, as far afield as South Africa
 - Masatoshi Ohishi recently attended SFCG in Japan





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 - **Work needed in Geneva far outstrips IUCAF resources**

