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
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.
Commonalities between OIR and radio

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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/yrvksz
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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?
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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Even remote and ‘quiet’ sites are subject to cell phone, car radars, satellites ...
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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 (∞–100µ)
  - 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.

- 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
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*
- 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.

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  - 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 ~20–30 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
How does spectrum management happen: III

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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
  - 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
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- **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