The Way Forward

Discussion
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The way forward is with undergrads, grads and postdocs

First question to undergrads, grads and postdocs:

• What did you find to be the most fascinating and mind-boggling research?
Science areas

• 1. CMB polarization (fundamental physics)
• 2 Cosmology (reionization, high-redshift gal.)
• 3. Galaxies (magnetism, gas)
• 4 Stellar evolution (star formation)
• 5 Stellar corpses (supernovae, black holes, neutron stars, planetary nebula)
• 6. Solar system (sun, Earth, planets)
• 7. SETI
Interest in technological development?

1. Interest in science aspect
2. Interest in telecommunications aspect and industry applications
Which scientific field is most promising for future discoveries?
Provocative statement

• We should rank science areas in importance

• We should rank instrumentation developments in importance

• We should pay more attention to publicity friendly research?
  – Breakthrough Listen Initiative, SETI, GBT et al. $100 Mill.
Unveiling the Cosmos

A Vision for Canadian Astronomy
Panel

“Make sure you begin your voyage of discovery before others realize there is something to be discovered.”
Ronald Naar (Dutch mountaineer)
Provocative statements

• In the time of survey astronomy and large networked collaboration, this statement of competitiveness is plainly wrong.

• You should go for what you think is fascinating (and be first). There is a lot more that can be done now technically and in the near future than there are astronomers to use these opportunities (M. Rupen).
Canadian strength and ambitions
Instruments for future science

- SKA
- ALMA Stage 2
- CMB-S4
Provocative statement

In 1967 VLBI was first demonstrated in Canada, but then astronomical aspect forgotten for 25 years while others made full use of the technique for lots of breakthrough discoveries.

That could never ever ever happen again!
Instruments for future science

- SKA
- ALMA Stage 2
- CMB-S4
SKA Statement

• If you want to play a role in radio astronomy on the big scale, you have to be in the SKA.
Provocative statement

• We play a dominant role in the SKA
  – Canada proposes to pay ~6% of the cost
  – Canada has about 20 people, mostly engineers of the 600 total SKA scientists and engineers (3%).
• Canada needs 36 scientists and engineers primarily for the SKA.
  – Why don’t we have them now?
  – Will the ALMA scientists and engineers transition to the SKA?
Provocative statement

• The TMT budget hole of $500M and the postponement of the construction does not affect at all Canada’s commitment to the SKA.

• ngVLA is sufficiently far ahead that our active role in the SKA can only benefit our future involvement in the ngVLA design and construction.
  – NRAO got $11M from the NSF for the development of ngVLA for the next decadal survey for the next two years. Announced today.
ALMA development (2030 and beyond)

• ALMA is Canada’s first $Billion class radio facility

• What does ALMA 2030-2050 look like?

• Does ALMA community migrate to SKA, ngVLT,
ALMA 2030

ASAC Recommended development paths
• 1. Improvements to the ALMA Archive
• 2. Larger bandwidths and better receiver sensitivity
• 3. Longer baselines; new science possibilities
• 4. Increasing wide field mapping speed
  – MULTI-BEAM RECEIVERS
  – only modest pixel counts w/o major redesign of the antenna optics

Is this enough to keep ALMA a premier facility beyond 2030?
CMB-S4 and the wider radio community

• Canada has played a (big) role in many CMB experiments, and is well poised to be a Stage4 player.

• Canada should work hard to develop our culture in the same way that the USA is forcing itself to do.

• Is there a ‘Triumph’ for stage-4 that’s reasonable (funding, organization, etc),
  – And can other Radio facilities tie into this and benefit from such a consolidation?
The future 25 years from now

• The SKA was conceived ~25 years ago
  – 100 x sensitivity of the VLA
• We should think about a telescope with $10^4$ x sensitivity of (old) VLA now.
Provocative statement

• No! Not possible! We are asymptotically reaching the limits of what radio astronomy can develop.
  – We should constrain ourselves to the next 10 years and pursue Canada’s strength and ambitions.

• Yes, we should start thinking of the new giant radio telescope.
  – Own technology?, CLAR_{smart} with drones instead of a balloon?, 1 Mill dipole array?
The End