

## TRANSIT OF VENUS 2012 JUNE 5

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### Your last chance for 105.5 years...

to witness one of the rarest of solar-system spectacles. 2012 June 5 marks only the fourth time observers in Canada will have been privileged to see a Transit of Venus (ToV). This presents a heaven-sent opportunity to:

-do education and public outreach (EPO—the RASC’s *raison d’être!*), and some modern citizen science

-grasp the thread joining Kepler, Hubble, and space telescopes in the cumulative process of measuring the universe, and recognize the genesis of methods of modern exoplanet detection in 18<sup>th</sup>-19<sup>th</sup> century ToV campaigns

-balance the heroism of the 18<sup>th</sup>-19<sup>th</sup> century expeditionary astronomers’ quest for data against the costs of colonialism for indigenous populations; and the needs of cutting-edge big science against the demands of the military-industrial complex with which it was and is creatively entwined

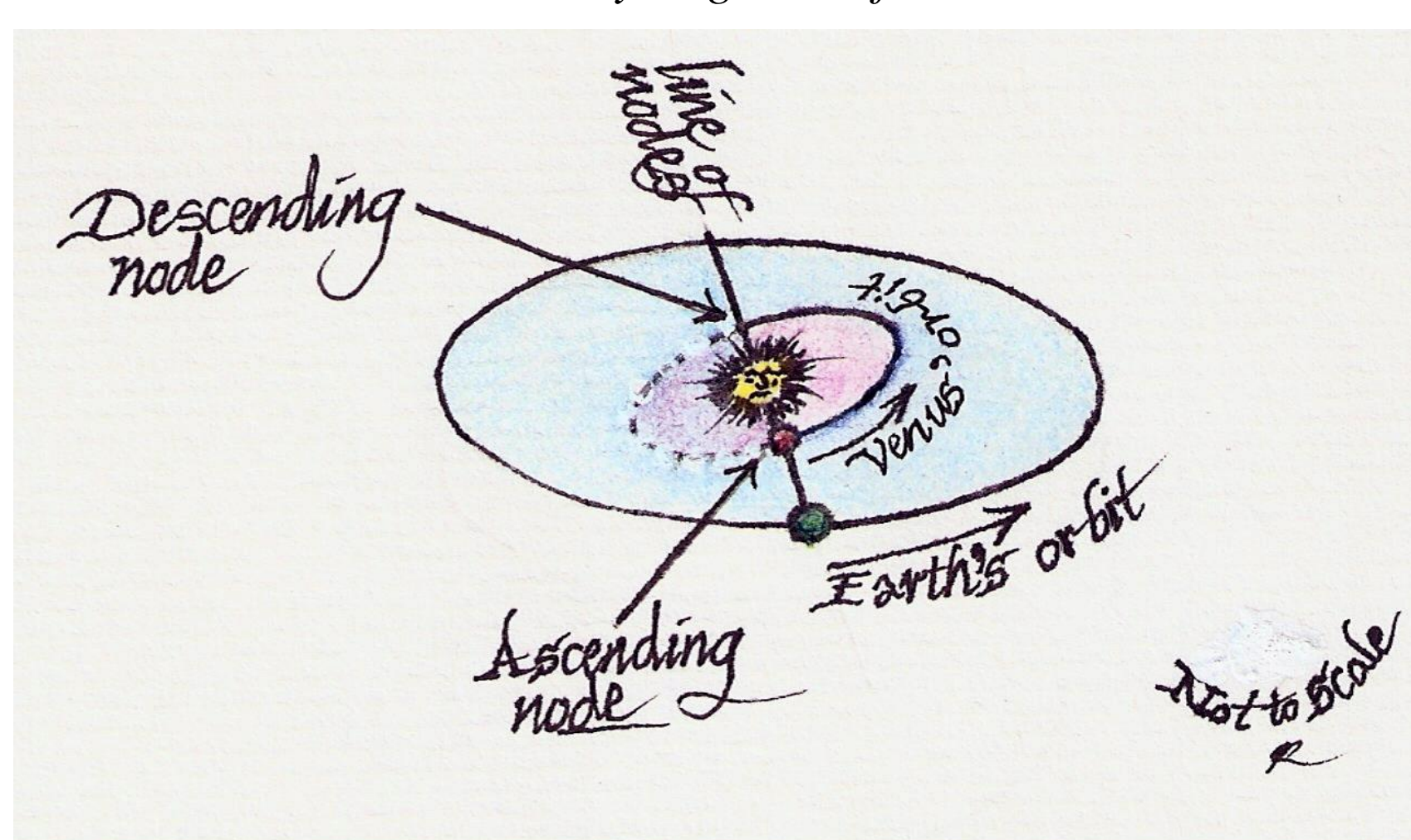
-do totally **MIND-BENDING** thought experiments through cognitive archaeology, & replicate **HISTORICAL** ToV observations through experimental archaeology to help clarify vital historical data & enrich EPO

... all-considered, not bad options for a June afternoon—and you can go to the pub when it’s all over (they did that in the 18<sup>th</sup> century too).

### So, what is a ToV?

Simply put, a ToV is an eclipse of the sun by Venus. In technical terms, it’s the passage of Venus across the solar disc when the planet is at or near an ecliptic node at inferior conjunction. The ToV is rare because the three bodies—Sun, Earth, & Venus—must line up in just the right way. ToVs occur in pairs separated by 8 yrs. (the first of the present pair was in 2004), ascending node pairs in December and descending node pairs in June. The periods separating transits are presently 8yrs.+105.5yrs.+8 yrs.+121.5yrs., giving a 243 yr. cycle. Why? The orbits of the Earth and Venus are nearly in resonances of 8:13 (i.e., 8 Earth orbits happen in the time of 13 Venus orbits) and 243:395 in respect to the nodal alignment necessary for a ToV. It wasn’t until Galileo’s lifetime that ephemerical prediction led to successful ToV observations in England by Horrox and Crabtree (Horrox also wrote some of the worst astronomy poetry ever—*don’t try this at home!*).

Planetary alignment for ToVs



R.A. Rosenfeld; SPECULA ASTRONOMICA MINIMA®

### Why should I care?

If you haven’t seen a ToV before, this is your chance to see something whose intellectual-visual impact outstrips conjunctions, occultations, some lunar and solar eclipses, most telescopic comets, and any reality TV scheduled for that afternoon. If you saw the 2004 ToV, then adding the 2012 ToV to your observing brag-list gives you, well, more bragging rights.

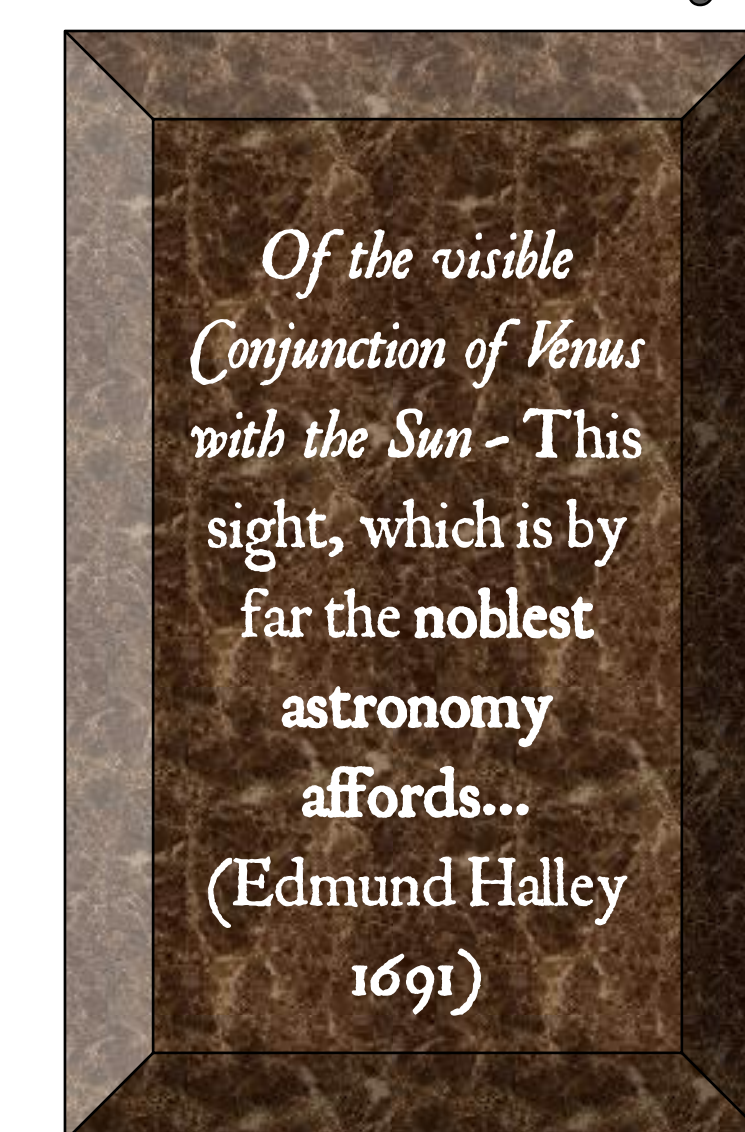
(“Wait a minute: *Intellectual-visual* impact—what’s that?” Well...) There is something electric in viewing a celestial phenomenon in the knowledge of its place in human culture, our cumulative scientific achievement won through harvesting its data and theorizing its meaning, and what we don’t yet know about it. (And remember, *science* is culture). Some of this context is bound to ignite a spark among the interests of those gathered to see what you’re looking at through your telescope setup on the lawn or near the street (**GUERRILLA** astronomy).

Much of the mystique of the ToVs stems from the incredible stories of observers’ astronomical endurance and fortitude. Le Gentil missed one ToV and hung around the far east for another 8 yrs. to see the next, only he couldn’t (clouded out; and people at home thought he had perished—perhaps he wished he had). Chappé d’Auteroche successfully observed his ToV, but died from yellow fever almost immediately afterwards (saving the trouble of a return journey). Mason & Dixon’s expedition got beat-up by unfriendly cannonballs. Winthrop was harried by Newfoundland’s finest insects, and Nevil Maskelyne before he got home had to make his way through a lot of expensive drink (doubtless assuaging the hurt—he too was cheated by cloud).

### Why did they do this?

For several reasons:  
 1) *pure science*—as we would now say. Disinterested investigation of the universe was seen as ennobling, because you did it out of a burning curiosity *to know*, and not in the interests of more sordid concerns. Intellectual and instrumental challenges were welcomed. According to worldviews of the time, the human creature was made for this;  
 2) *applied science*—science in the service of military glory, commercial dominance, and national prestige. The scientific goal of the ToV was to derive the Sun-Earth distance (the Astronomical Unit [AU]) from the solar parallax, and thus more accurately to begin to scale the universe. An accurate figure for solar

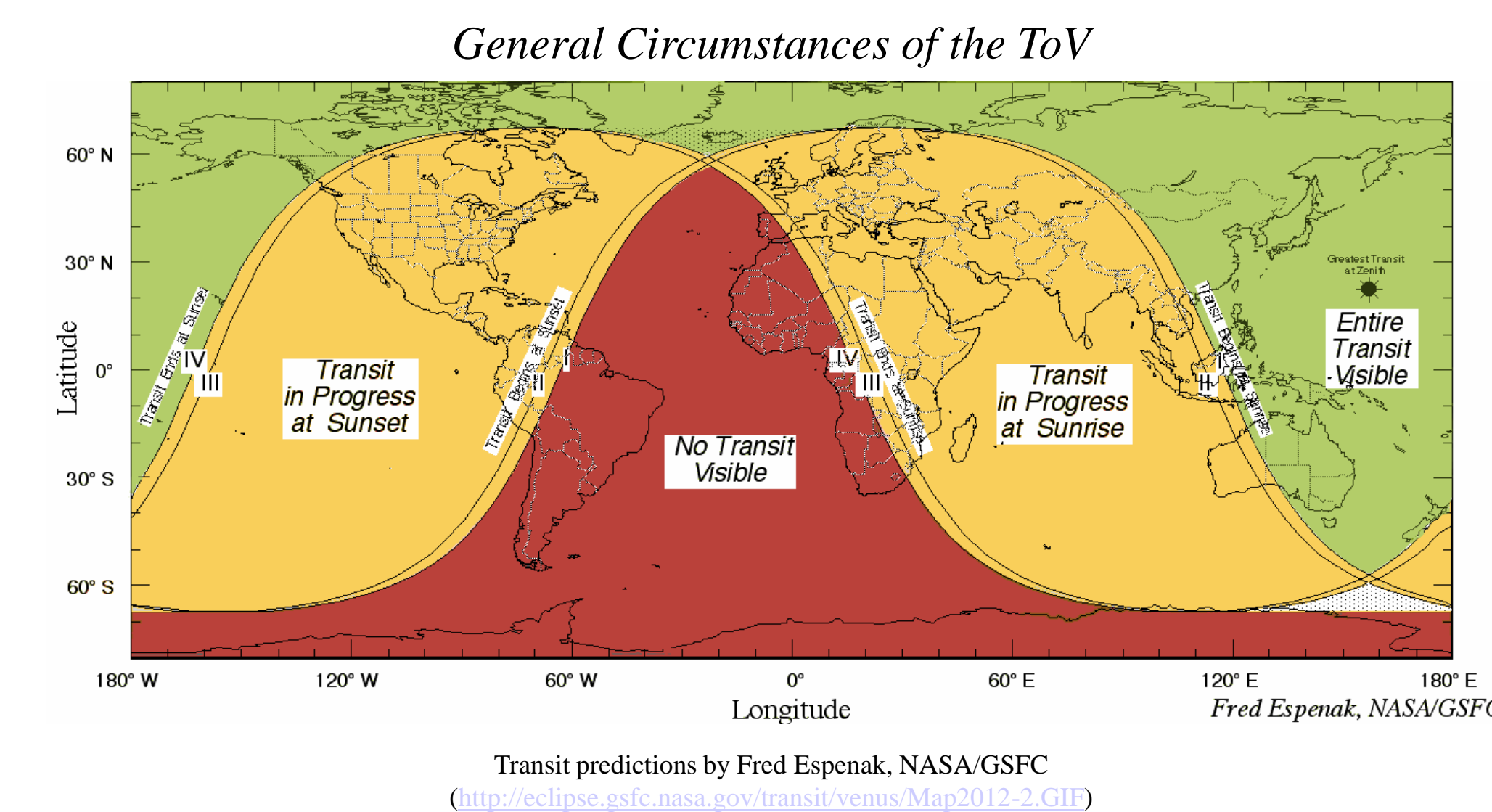
parallax also meant accurate corrections could be applied to readings of solar altitude to correct for atmospheric refraction & parallax. That meant a much better idea of your longitude on the high seas, which meant your naval vessels were less likely to feature in future as shipwrecks on *Pirates of the Caribbean*®, and your merchantmen could actually reach port with their casks of port and other valuable cargo *largely* intact (aside from losses due to onboard sampling). National prestige? Well, if you were a king and saw that *other* king sending his astronomers off for scientific glory you were damned if you weren’t going to send out a superior team to show whose court could do it better (a symbol of who had greater earthly resources & heavenly patronage). There was an element of glory for the astronomers as well (prizes, positions, and finer port). And if your earthly patron expected you to go on a ToV expedition, you did (or *else!*).



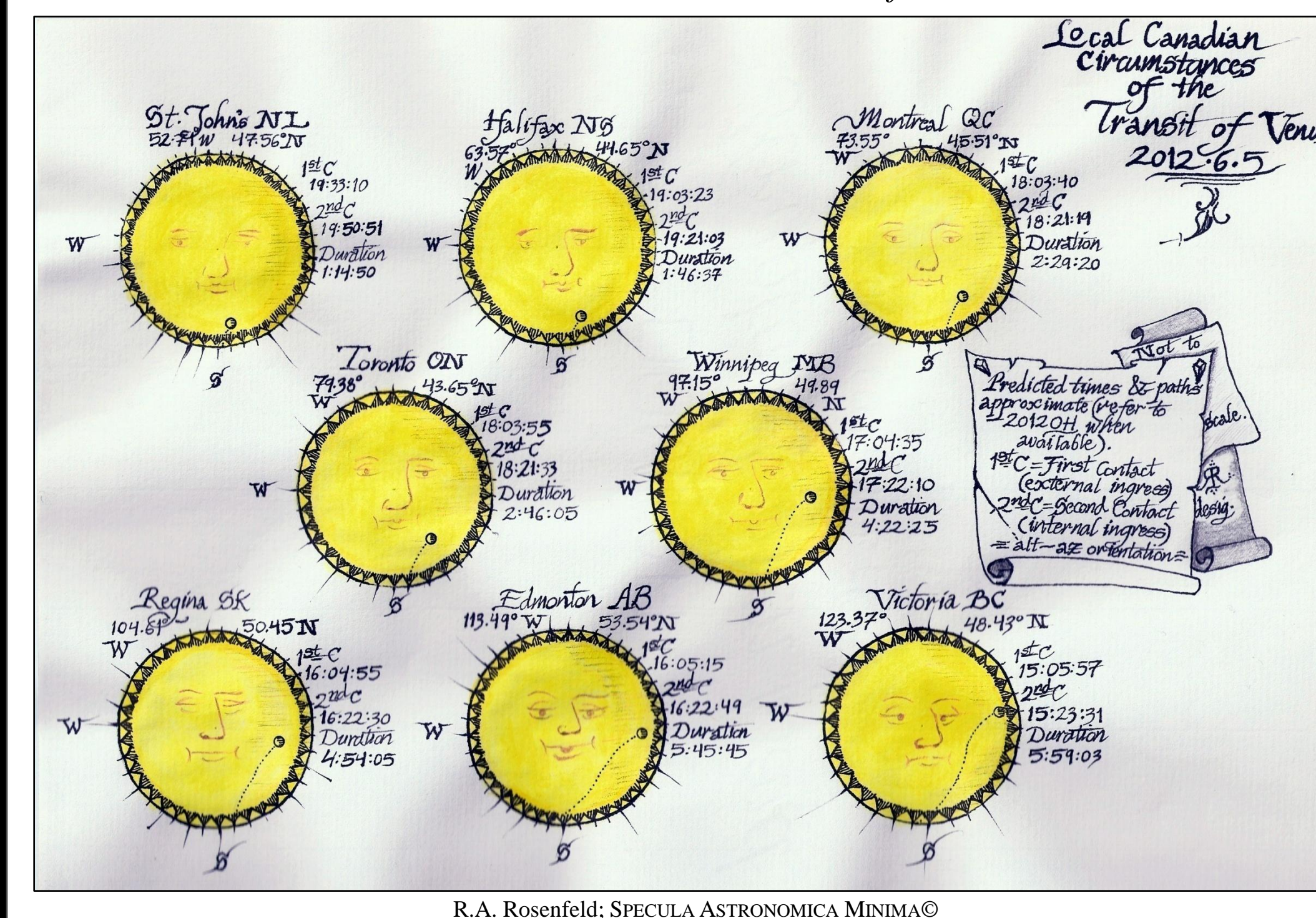
The approaching transit of Venus over the Sun has justly engaged the attention of Astronomers, as it is a phenomenon seldom seen, and as the parallax of the Sun and planets, and their distances from one another, may be found with greater accuracy by it, than by any other method yet known. (George Ferguson 1761)

### Circumstances of the ToV in Canada

Unlike the case on 2004 June 8, when the ToV was not visible from southern Alberta and most of BC, no part of Canada will be excluded from witnessing some portion of the ToV on 2012 June 5. In many locales the ToV will be of longer duration, too.



### Local Canadian Circumstances of the ToV



Remember, viewing the ToV is a variety of solar observing, so safety—yours and the public’s—must be placed uppermost:

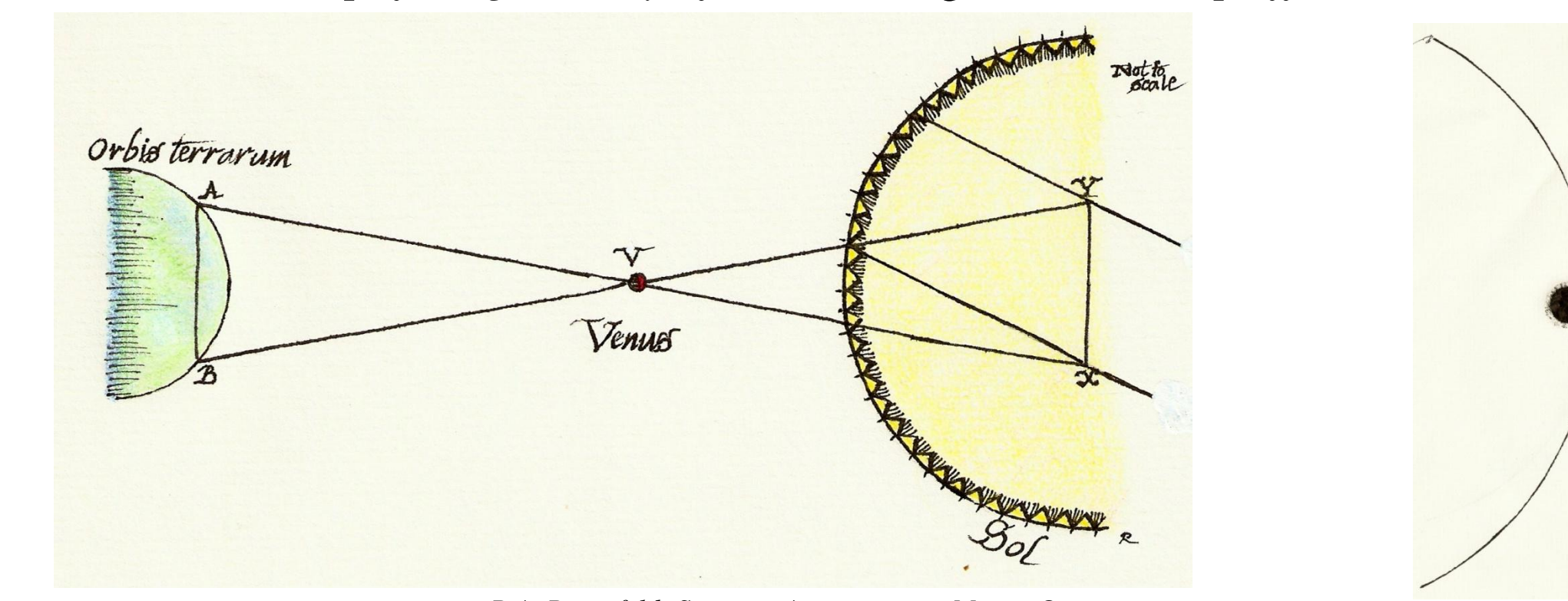
- never stare directly at the Sun without appropriate equipment
- do not let children view the Sun unsupervised
- do not leave astronomical equipment unattended where children or untrained adults can come to harm
- thoroughly inspect your solar-safety equipment before each use to insure its proper functioning

Solar projection equipment (refractors or Newtonian systems only, using eyepieces without cemented elements, and no plastic anywhere in the optical train!), Sunspotter® or Solarscope® or equivalent, Baader Planetarium® or Thousand Oaks® or similar white-light objective filters, Herschel wedges, hydrogen-alpha or calcium-K systems, Rainbow Symphony® or similar filters or #14 welder’s glass are all safe if used according to the manufacturers’ instructions. **Never use ocular filters alone for telescopic solar viewing!**

### It can’t be that difficult...

Edmund Halley (Astronomer Royal) and J.-N. Delisle (Charles Messier’s mentor) both devised spherical trigonometrical methods to derive the solar parallax from ToV observational data. The math was straightforward (similar triangles are a wonderful thing!), and taken in conjunction with Kepler’s 3<sup>rd</sup> law ( $P^2 \propto a^3$ ), an accurate value for the AU seemed within reach. Alas, not—it proved surprisingly difficult to achieve the required accuracy in timing the stages of contact. Amongst the chief sources of error was the black-drop effect, a distortion in Venus’ appearance. At one time attributed to Venus’ atmosphere, now

left: simplified geometry of the ToV; right: black-drop effect



the cause is sought in terrestrial atmospheric turbulence, optical defects, or limited aperture. Will you see it on 2012 June 5?

### Stuff to do!

The *Transit of Venus Project of Astronomers Without Borders* offers a variety of exciting ways to participate in the ToV:

**MEASURE THE SUN’S DISTANCE.** Determine the AU following Halley and Delisle’s methods, but with a very modern twist. The phone app under development will facilitate timing the contacts on June 5 (and practicing for them), submitting the essential data, & even repeating the Hallean style of calculations yourself!

**MARK THAT SITE!** Imagine observing the 2012 ToV from the site of an earlier ToV! Join us in visiting, inventorying & possibly restoring or marking significant sites of past transit expeditions. Locating these sites helps to safeguard our astronomical heritage.

**EXPERIMENTAL ARCHAEOLOGY.** Have you ever wondered how the ToV observations were actually made in the 18<sup>th</sup> & 19<sup>th</sup> centuries? Earlier technologies and techniques can create exciting EPO. They can also serve serious research ends, such as clarifying the reality of past observations, or revealing what was left out of past accounts.

For more details see: [www.transitofvenus.nl](http://www.transitofvenus.nl)

### References

Two recommended books are:  
 Arlot, J.P. et al., *Le passage de Venus* (Paris: EDP Sciences, 2004)  
 Martou, C., *Les passages de Venus. Histoire et observation d'un phénomène astronomique* (Paris: Vuibert, 2004)  
 The best short treatment of the history is:  
 Helden, A. van, “Measuring Solar Parallax: the Venus Transits of 1761 and 1769 and their Nineteenth-Century Sequels”, in *The General History of Astronomy. Planetary Astronomy from the Renaissance to the Rise of Astrophysics: The Eighteenth and Nineteenth Centuries*, ed. R. Taton & C. Wilson, 2B (Cambridge: Cambridge University Press, 1995), pp. 153-168  
 Still of value, though in need of revision is:  
 Woolf, H., *The Transits of Venus: A Study of Eighteenth-Century Science* (Princeton: University of Princeton Press, 1959)  
 Two useful websites are:  
<http://transitofvenus.nl/wp/>  
<http://www.transitofvenus.org/>  
 There are also books in English by Eli Maor (Princeton University Press, 2004), Roy Bishop, Fred Espenak, and Jay Anderson have good articles in the *Observer's Handbook 2012*. And read Peter Broughton’s paper on the Canadian record of ToV observations: <http://www.rasc.ca/history/transit.pdf>