DDA 2008 POSTER PRESENTATION:

Predicting Iridium Flares

A Poster Presentation for the 39th Division on Dynamical Astronomy (DDA) Meeting of the American Astronomical Society (AAS), April 28 - May 1, 2008, Boulder, Colorado U.S.A.

by

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Abstract

At present there is a "constellation" of 66 active Iridium communications satellites and nine spares, all moving along in nearly-circular orbits at an altitude of approximately 780 km above Earth's surface. The Iridium satellites are arrayed into six moving orbit planes tilted 86.4 degrees to the celestial equator and spaced at equal intervals of right ascension around it. Each orbit plane contains eleven active satellites spaced at equal intervals of mean anomaly.

Each Iridium satellite has three highly-reflective, mirror-like antennas, called "Main Mission Antennas" (MMAs), which are tilted down 40 degrees from the vertical axis of the spacecraft and spaced 120 degrees apart. Should an Earth-fixed observer be looking in the direction of one of these antennas and see the reflection of the Sun through it, he or she will observe, for a few fleeting seconds, a bright flare of sunlight that can exceed visual magnitude -8. Such a solar reflection, called an "Iridium flare," typically happens several times a day to any Earth-fixed location, although several days may go by with no Iridium flare visible to a given Earth-fixed observer.

The attitude of each Iridium satellite is maintained on-orbit according to the following control law: "long axis down, MMA #1 forward." Since this control law dictates the precise orientation in space of each MMA at all times, it is possible to predict Iridium flares, given also that the dynamicist has in hand the current orbital elements of each Iridium satellite.

Therefore, as part my poster presentation, I will show how to make Iridium flare predictions using the algorithms that I have developed for this purpose. I will predict the Iridium flares, if any, that can be see from Boulder, Colorado, during each night of the DDA meeting.

Iridium Flare Predictions for Boulder, Colorado

Predictions for Boulder can be found at **http://www.astroger.com.** Follow the link to **http://home.att.net/~sky_watcher/**.

Background

Back in 1997, when the Iridium satellite constellation was first being populated, **Randy John** and **Rob Matson** independently developed computer programs to predict Iridium flares (see Chien, Philip, "Have You Been Flashed by Iridium?" *Sky & Telescope,* May 1998, pp. 36-41). These programs were free, but were not entirely user friendly, as they did not take advantage of the Windows nor Mac OS graphical user interface.

Then, not long after Randy John and Rob Matson announced their Iridium flare prediction programs, **Chris Peat** put up the **Heavens Above** website, which also provides free Iridium flare predictions. The predictions are quite easy to obtain (visit **http://www.heavens-above.com**), and the browser-based interface is rather pleasing and user friendly.

At this point, one might reasonably ask, why should there be any further need for programs that do Iridium flare prediction, such as the Firebirds program that is the basis for my DDA 2008 poster presentation?

The short answer is this: better Iridium flare magnitude measurements are needed in order to establish a definitive magnitude law for Iridium flares. And the Firebirds program, as now integrated with Software Bisque's **TheSkyX** computer program (see **http://www.bisque.com**), facilitates the location and observation of Iridium flares in a particularly effective manner.

Better Iridium Flare Magnitude Measurements are Needed

All of the currently available magnitude estimates, regardless of source, are rather imprecise. To the best of my knowledge, no comprehensive and definitive magnitude law has ever been established or published.

The magnitude estimates from currently available sources are sufficient to distinguish brighter flares from dimmer ones. But there remains a need for precise photometry to determine Iridium flare magnitude as a function of spacecraft structure, orientation, mirror angle, distance to observer, and atmospheric conditions.

Firebirds/TheSkyX Facilitate the Study of Iridium Flares

My own Firebirds computer code, which, as of January 2008 has been integrated with Software Bisque's new **TheSkyX** computer program, is based upon the magnitude vs. mirror angle curve developed by Randy John. I cannot claim that Firebirds is any more efficient or effective, as a standalone program, than Randy John's and Rob Matson's programs. And it is by no means as easy to use as Heavens Above's browser-based prediction capability.

But the incorporation of Firebirds into TheSkyX has made for an Iridium flare prediction capability that uses a Windows or Mac OS-based interface, and which provides **a realistic, animated simulation** of Iridium flares. TheSkyX now greatly facilitates the location and observation of Iridium flares.

Also, it is now possible with TheSkyX to specify which Spacetrack* orbital elements are to be used in the flare predictions, and to study past flare events, given the historical orbital elements, as well as flare events forecast for the immediate future (up to at most about 14 days into the future, due to the unavoidable accuracy limitations of Spacetrack two-line orbital elements).

*Although orbital elements can be directly obtained from Spacetrack (visit **http://www.space-track.org**), Celestrak's elements (to be found at **http://celestrak.com**) are to be preferred because Celestrak provides the status of each Iridium satellite: active [+], spare [S], or inactive [-].

Concluding Remarks

It is my hope that both professional and advanced amateur astronomers, now aided by TheSkyX and its new Iridium flare prediction capability, will make and publish precision astrometric and photometric observations of Iridium flares, so that a definitive magnitude law for Iridium flares can be deduced.