Solar Spectrum View Factor Calculation

Three different TMG entities require the calculation of solar spectrum heat loads: *Orbit/ Attitude Modeling, Diurnal Solar Heating* and *Radiative Heating.*

Sun and albedo (planet reflection) are the solar spectrum sources in the first two types of analysis, although albedo is optional. In *Radiative Heating* the solar spectrum source is an element, or a group of elements, modeling a solar spectrum source (for example, the filament of a lamp). Note that *Orbit/Attitude Modeling* and *Diurnal Solar Heating* can include *Radiative Heating* entities.

The calculation of solar spectrum view factors is performed in the same way for these three types of analysis, with minor variations to account for differences in their applications. For example with *Orbit / Attitude Modeling*, albedo is modeled as reflection from a sphere of appropriate size, whereas with *Diurnal Heating* ground reflection is from a planar surface just below the model.

Direct Solar Spectrum Flux Calculation

To calculate the heat loads on the elements, TMG determines which elements have a direct view to the sources of heat flux. Direct incident radiation from each source is determined using view factors. *Solar view factors* reflect the amount of energy an element receives from the solar source which is modeled as a distant point source for *Orbit / Attitude Modeling* or *Diurnal Heating*.

As for *black body view factor*s, unobstructed solar view factors are computed accurately and efficiently using a contour integral algorithm; solar view factors which are shadowed by intervening elements are handled using element subdivision.

The incident radiation on any element is simply the product of its view factor to the source multiplied by the flux from the source.

If the incident flux falls on elements which are not perfect absorbers, some of it will be reflected diffusely or specularly to other elements in the model. Diffuse and specular reflection are explained in the following two sections.

For *Orbit/Attitude Modeling* all the view factors are computed from the illuminated elements to the sources at all calculation points in the orbit. Planet view factors are also computed to calculate Planet IR radiation. Unshadowed planet view factors are calculated using an exact analytical method. For albedo view factors, the variable illumination of the planet is accounted for. For albedo heating, the ambient flux is determined using the tables of Stevenson and Grafton.

Diffuse Reflection

To include the effect of diffuse reflection in the heat load calculation, a *Radiation Request* must be performed for the elements. Without this *Radiation Request*, TMG calculates solar heat loads only for elements with a direct or specular view to the source, diffusely reflected solar energy will not be modeled.

Be careful in defining your enclosure for this *Radiation Request*; it cannot contain elements for which solar view factors cannot be calculated. (Elements selected with the option *Ignore Elements for all Solar/Orbital/Radiative Heating* or *Ignore Elements for all View Factor Calculations* of the *Element Radiation Switches* or those with an absorptivity less than 0*)*.

TMG models diffuse reflection using a radiosity approach and uses the solar and IR radiative couplings to compute a total view factor for each element, and the resulting heat loads. The IR radiative couplings are calculated with the black body view factors obtained from the *Radiation Request* (see *Black Body View Factor Calculation).* Total view factors to a source can be greater than 1 because of focusing effects. For *Orbit/Attitude Modeling* total sun, planet and albedo view factors are calculated for each element.

Two of the main assumptions of this approach are that:

- the incident radiation on an element is uniformly distributed
- the radiation reflected from an element is distributed in direct proportion to its view factors

Some of the situations where these break down are discussed under *Radiation Control*.

Note that for models exposed to the environment, the view factors to the ambient environment (*Space Enclosure*) are critical to arrive at an accurate overall heat load on the model.

Include Shadowing Checks

TMG performs *shadowing checks* to calculate the *solar view factors* of elements that have their view of the solar spectrum source shadowed by intervening elements. As for the black body view factors, the Nusselt Sphere technique is used to calculate partial view to the solar source.

Unlike the black body view factor sum, the solar view factors sum of an element does not have to equal one. An element with a solar view factor of one is simply an element with an unobstructed view to the sun.

The *Error Criterion* option functions differently for solar view factors than it does for black body view factors. It does not specify an acceptable error for the view factor sum. The *Error Criterion* for solar view factor shadowing checks is rather a relative indication of the level of precision required, smaller error values yielding more precision. Alternatively, you can specify a unique subdivision value to apply to all shadowed elements with the *Fixed Subdivision* option.

You can post process solar and Earth view factors (see *Solution Data*).

Ray-Tracing

In computing solar view factors, TMG automatically uses ray-tracing to model transmission and specular reflection. Collimated rays are launched only from specular or transmissive elements which have direct solar view factors greater than zero.

The ray-tracing process is used to correct the direct solar view factors to account for specular images of the sun. The radiosity approach is still used to model the diffuse reflections in the enclosure.

To perform Ray-Tracing for diffuse reflection and IR, toggle *ON* the *Ray Trace to enhance Specular/Transparent Accuracy* option on *Radiation Request.* (See *Ray-Tracing)*.
