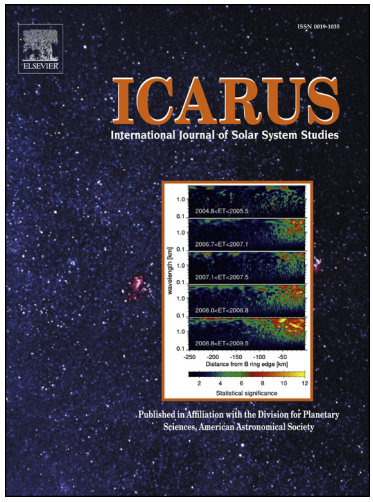

Detectability of Planetesimal Impacts on Giant Exoplanets

Laura Flagg, Alycia J. Weinberger, Keith Matthews

PII: S0019-1035(15)00368-1
DOI: http://dx.doi.org/10.1016/j.icarus.2015.08.024
Reference: YICAR 11695

To appear in: *Icarus*

Received Date: 30 January 2015
Revised Date: 14 August 2015
Accepted Date: 19 August 2015

Please cite this article as: Flagg, L., Weinberger, A.J., Matthews, K., Detectability of Planetesimal Impacts on Giant Exoplanets, *Icarus* (2015), doi: http://dx.doi.org/10.1016/j.icarus.2015.08.024

Detectability of Planetesimal Impacts on Giant Exoplanets

Laura Flagg[a,b,*], Alycia J. Weinberger[b], Keith Matthews[c]

[a] *Department of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010, USA*
[b] *Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road NW, Washington, DC 20015, USA*
[c] *Caltech Optical Observatories, California Institute of Technology, MC 301-17, Pasadena, CA 91125, USA*

Abstract

The detectability of planetesimal impacts on imaged exoplanets can be measured using Jupiter during the 1994 comet Shoemaker-Levy 9 events as a proxy. By integrating the whole planet flux with and without impact spots, the effect of the impacts at wavelengths from 2 - 4 μm is revealed. Jupiter's reflected light spectrum in the near-infrared is dominated by its methane opacity including a deep band at 2.3 μm. After the impact, sunlight that would have normally been absorbed by the large amount of methane in Jupiter's atmosphere was instead reflected by the cometary material from the impacts. As a result, at 2.3 μm, where the planet would normally have low reflectivity, it brightened substantially and stayed brighter for at least a month.

Keywords: comets, debris disks, extra-solar planets, Jupiter

1. Introduction

The frequencies with which giant planets and cold circumstellar debris disks encircle old (i.e. >1 Gyr) Sun-like stars are both ∼20% (Eiroa et al. 2013; Marshall et al. 2014). The debris disks are generated in the collisions and evaporation of planetesimals, analogous to the comets and asteroids of today's Solar System. That most debris disks contain cold, ∼50 K, dust indicates that the reservoirs of parent bodies are at ∼100 AU from the parent stars, in a region analogous to our Edgeworth-Kuiper Belt. These cold debris disks appear to be equally common for planet-hosting and non-planet hosting stars (Bryden et al. 2009), though the known planets in these systems are all within a ∼1 AU of their stars. Detectable disks are at least 10–100× dustier than our Edgeworth-Kuiper Belt (Bryden et al. 2006; Eiroa et al. 2013), with correspondingly larger parent body populations and are thus even more subject to frequent collisions between bodies.

In today's Solar System, planetesimals infrequently hit planets; although, in the past, such impacts were much more common. The cratering rates on the Moon and Mars indicate that the impact rates were high prior to ∼800 Myr after the formation of the Solar System, perhaps ending in a "Late Heavy Bombardment" (see e.g. Strom et al. 2005, and references therein). Today, a comet larger than 1 km in diameter impacts Jupiter only every few hundred years (Nakamura and Kurahashi 1998; Zahnle et al. 2003; Schenk et al. 2004). One such collision was that of Jupiter and Shoemaker-Levy 9 (SL9) in July 1994. SL9 was a Jupiter Family comet, a class of objects believed to originate in the Edgeworth-Kuiper Belt (Schenk et al. 2004). During a pass of Jupiter in 1992 the comet was tidally disrupted and broke into ∼25 fragments (Schenk et al. 2004). Three of these fragments were still quite large – >1 km in diameter (Harrington et al. 2004; Crawford 1997). Fifteen fragments produced impacts detected by the Hubble Space Telescope (Hammel et al. 1995), as the comet impacted the planet over the course of seven days.

In this paper, the impact of Shoemaker-Levy 9 on Jupiter is considered as a case study for assessing the observability of impacts on giant exoplanets. The comet impact caused visible changes in Jupiter's

*Corresponding author
Email addresses: laura@nau.edu (Laura Flagg), weinberger@dtm.ciw.edu (Alycia J. Weinberger)