Characteristics of the Origins Billion Star Survey (OBSS)

- Excellent Temporal Coverage:
  - Observe between 45 &135^{o} sunangle
    - About 2000 observations in 5 years
    - Observing windows (OW) lasting 2 to 3 hours
    - 10 Focal Plane Crossings per OW
    - 20 to 30 observations per OW
    - Observes a new ~20% of the sky each day
    - Two OW's per Precession Periods
    - Observes 70% of sky per Precession Period (20^{days})

Temporal Characteristics Are Ideal for Detecting & Characterizing close-in Near-Earth Asteroids (NEARs)

Follow Hills & Leonards, 1995, AJ, 109, 401

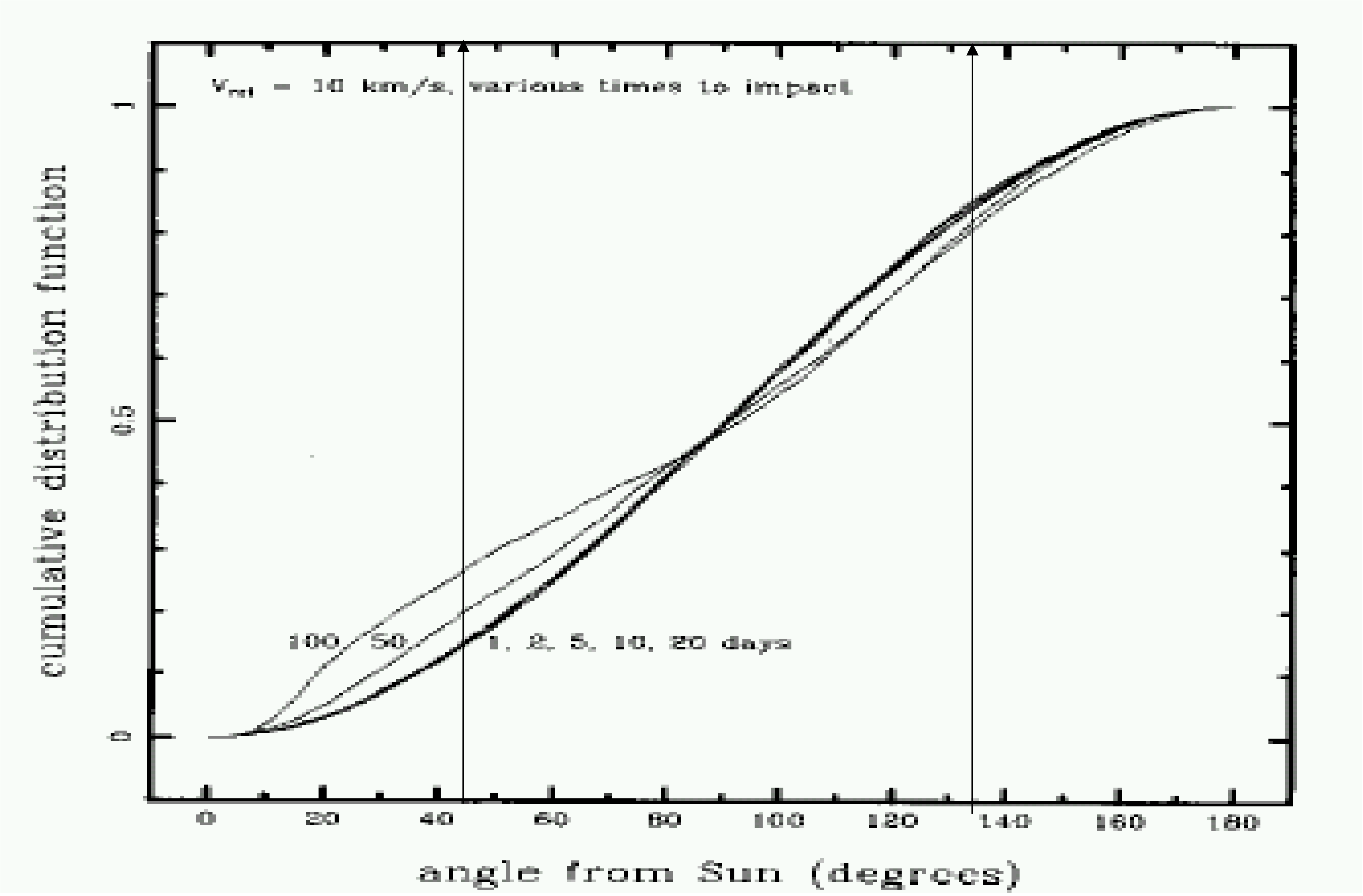
Analysis of NEARs about to inpact, or nearly miss Earth:

- Distances <~ 0.1 AU
- NEARs come from all directions
- Have **large** proper motions: 250 arcsec/day (median)
  - ~ 10.4 arcsec/hr ~ 1.6 arcsec every 10 seconds ~ 6.7 PSFs/CCD transit
- @ 10 days to Impact/Near-miss, a *100 meter* NEAR has:
  - V=20 @ 45 degrees Sunangle (SA): Invisible due to smearing
  - V=15 @ 135 degrees Sunangle (17^{th} mag with smearing)

<u>OBSS & NEARs:</u>

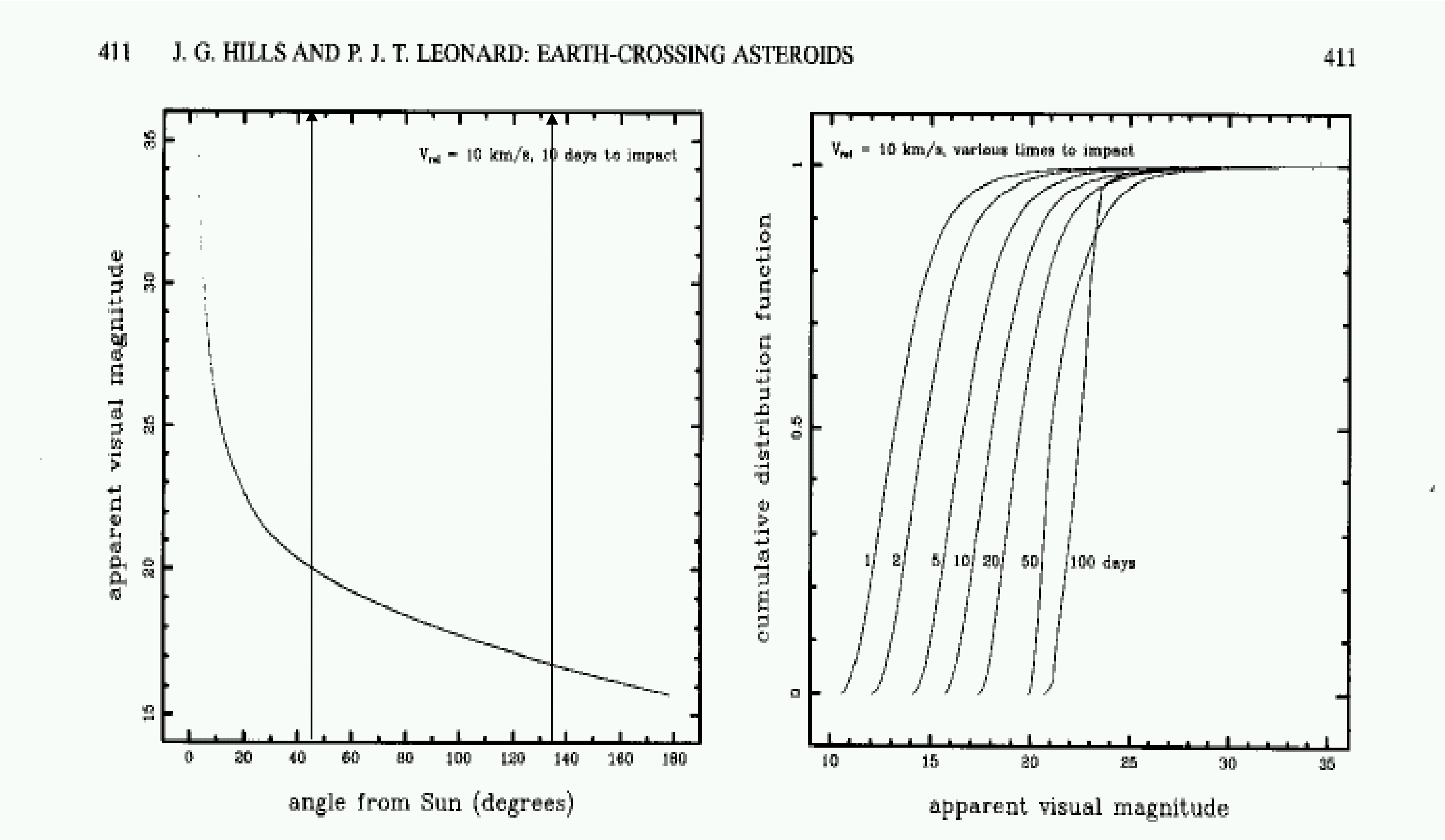
- Detect NEARs if SA >~100^{o}, or at ~33%
- Proper motion determination per Focal Plane Transit:
  - @ SA=135 & V=15 ==> 0.6 mas / 10 seconds & S/N=4000
  - @ SA= 45 & V=20 ==> 11 mas / 10 seconds & S/N= 182
- 10 Confirmation Opportunities during 2 hour Observing Window

Sun Angle Distribution for About-to-Impact or near-miss NEARs



Apparent Visual Magnitude of near-impact/near-miss NEARs

- 10 days to impact/near-miss (left)
- For various times to impact/near-miss (right)



Astrometry of (Almost) Impacting NEARs

- Huge proper motions @ 10 days to (almost) impact
- Huge parallax on a 12,000 km baseline

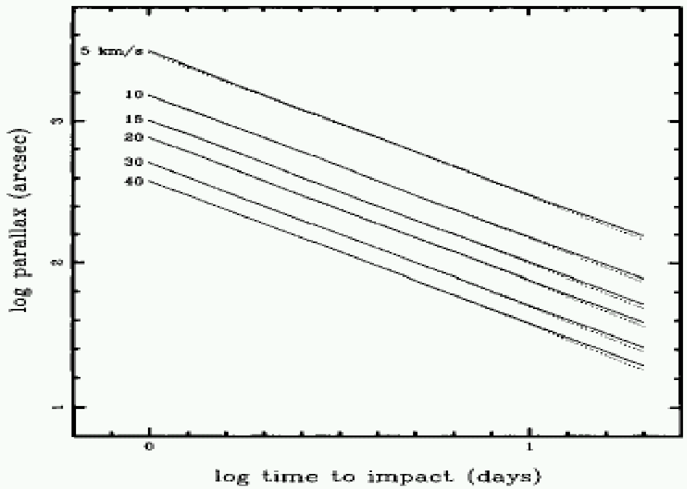


FIG. 15. Range in parallax vs time to impact for asteroids that will hit Earth that approach Earth isotropically at various relative impact speeds. The solid and dashed curves represent the upper and lower limits of the range, respectively. Asteroids with parallaxes lying outside the range will miss Earth. The parallax is calculated assuming a baseline of one Earth radius.

Earth impact has a small proper motion, a large parallax, and is becoming brighter.

At a 10 km s^{-1} impact speed and 10 days from impact, the objects are at a distance of about 8.6×10^6 km or 0.058 AU. Their parallax at a projected separation of 1 $R_\oplus$ is about 150 arcsec=2.5 arcmin, which is readily resolved with wide angle cameras. If an asteroid 100 m in diameter or larger hits Earth every 300 yr (Shoemaker *et al.* 1990, 1991), then about 6000 asteroids with diameters greater than 100 m pass within 0.058 AU of Earth each year.

3.7 Geocentric Proper Motion

The geocentric proper motion of an asteroid is found by comparing the position vector of the asteroid relative to Earth at the desired time to impact with the relative position vector from a few minutes earlier. The angle between the two vectors divided by the time difference yields the proper motion. We refer to this proper motion as being "geocentric," since it is measured with respect to the center of the moving

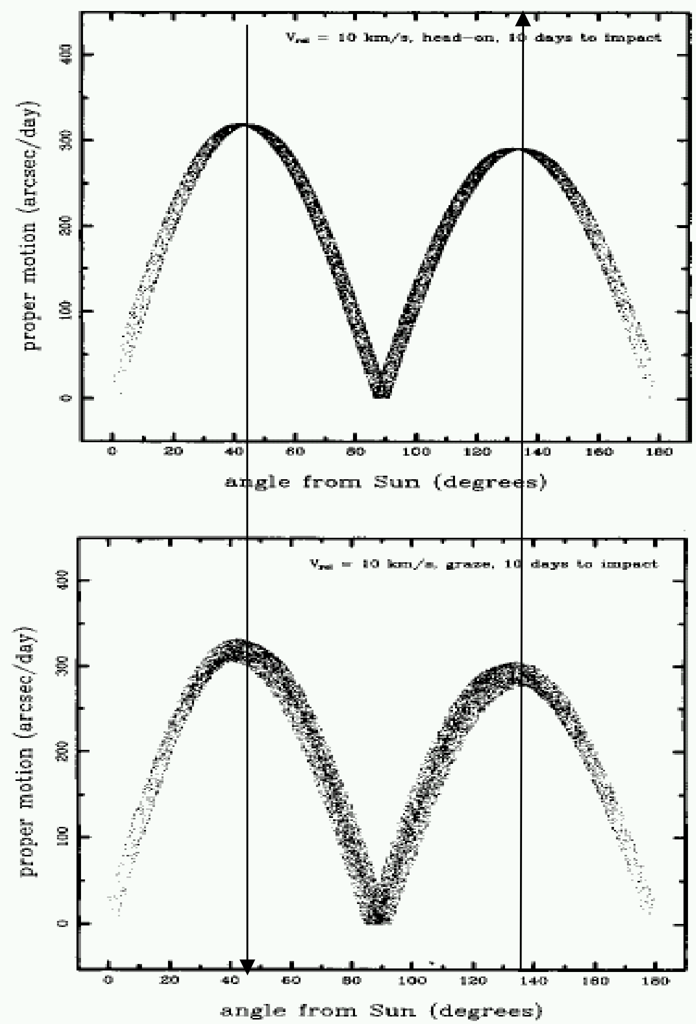


FIG. 16. Daily geocentric proper motion vs angle from the Sun for asteroids that approach Earth isotropically at a relative impact speed of 10 km s^{-1} at 10 days to impact. The distributions for head-on and grazing collisions are shown.