

is about 0.65. Also the distribution of rotational velocities is examined.

## **Umbral Chromospheric Cavity Oscillations for Slow Mode Magneto-Acoustic Waves**

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Umbral chromospheric resonant cavity for slow mode magnetoacoustic waves is considered to interpret 3 min. oscillations observed above sunspots. The resonance cavity has been investigated by calculating the transmission coefficients of the waves propagated through the umbral photosphere and chromosphere into the corona with various periods. For this calculation we made use of multi-layer approximation by representing the atmosphere by a number of separate layers with temperature varying linearly with depth within the individual layers. The medium is assumed to be compressible and permeated with a strong uniform magnetic field parallel to the gravity.

The resonant periods and transmission coefficients calculated for various umbral chromospheric models are presented and their model dependent characteristics are discussed.

## **Distribution of Zodiacal Dust Particles in the Ecliptic Plane**

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Two methods are developed for deriving from the observations of zodiacal emission the heliocentric distance  $r$  dependence of the volumetric absorption cross-section,  $n(r)\sigma_{\text{abs}}(r;\lambda)$ , of zodiacal dust particles. One of the methods is employed to analyze the observed elongation dependence of the zodiacal emission at 11  $\mu\text{m}$  and 21  $\mu\text{m}$ . The resulting  $r$ -dependence of  $n(r)\sigma_{\text{abs}}(r;\lambda)$  depends on wavelength  $\lambda$ , and its difference between the two wavelengths increases with  $r$ . It is also found that the  $r$ -dependence of  $n(r)\sigma_{\text{abs}}(r;\lambda)$  in the infrared region cannot be described by a single power-law relation which is frequently used to describe the  $r$ -dependence of volumetric scattering cross-section  $n(r)\sigma_{\text{sca}}(r)$  in the visible region. Implications of the discrepancy between the IR emission and visible scattering will be presented for the heliocentric dust density distribution and for the variation of dust optical properties in the inner solar system.

## **A Method for Deriving the Heliocentric Dependence of Volumetric Absorption Cross-Section from the IR Zodiacal Emission**

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The zodiacal infrared brightness integral is numerically carried out by substituting the following parametric representation for the volumetric absorption cross-section  $\zeta(r)$ :

$$\zeta(r) = \alpha r^{p_1} + (1 - \alpha) r^{p_2},$$

which is a combination of two power-law relations containing 3 parameters. Employing the non-linear

least squares method, we minimize residuals between the calculated and observed IR brightness distribution of the zodiacal emission with respect to the 3 parameters  $\alpha$ ,  $p_1$ , and  $p_2$  of trial  $\zeta(r)$  function. Thereby we determine the volumetric absorption cross-section as a function of the heliocentric distance. Implication of the result for the properties of the zodiacal dust cloud will be discussed briefly.

## **MM Wave Observations of Late Type Carbon Star, IRC+10216**

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The NRO (Nobeyama Radio Observatory) 45 m radio telescope has been used for a high resolution mapping observation of the late type carbon star, IRC+10216. The four molecular spectra (HCN  $J=1-0$ ,  $H^{13}CN$   $J=1-0$ ,  $C_4H$   $N=9-8$ ,  $C_3N$   $N=9-8$ ) were simultaneously obtained with the Acousto-Optical Spectrometer (AOS). The HCN and  $H^{13}CN$  profiles show evident hyperfine components and their atmospheric structure is considered not simple. The spatial distribution of HCN emission reveals more central concentration than that of CO emission. Expanding envelope model is applicable to interpret these features.

## **Velocity Structure in Bipolar Molecular Outflows**

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The velocity structure in bipolar molecular outflows (BMO) has been studied and the physical attributions have been discussed. The relation between physical parameters, especially  $D$  (extended distance of the observed lobes) and  $V$  (observed expansion radial velocity of the BMO) has been analyzed using cross-plot with the observational data (Lada 1985). The obtained relation,  $V \propto D^{-0.6}$  is reasonable for the interpretation of the velocity structure in the BMO. It would be interpreted with the ram pressure deceleration effect and the buoyancy effect by density difference.

## **Stellar Populations in External Galaxies. I.**

### **Unconstrained Synthesis Models and Metallicity Problem.**

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Unconstrained population models for several elliptical and spiral galaxies are obtained from their integrated spectra. Spectral energy distributions (SED's) of 49 stellar groups published by O'Connell (1973) are used as input basis and "Linear Programming" algorithm is applied to the galaxy population synthesis problem. The reliability of the newly composed computer program is well-qualified.

The intrinsic strength anomaly (ISA) problem suggested by Taylor and Kellman (1978) is examined with our models, and it is concluded that the stellar SED library seems to be incomplete.