ABSTRACTS:

Oral Presentations

Session I:

Status of the NYAC Telescope Project

Chris O'Dea (Rochester Institute of Technology)

I will review progress towards obtaining a 12-m telescope for the use of the NY astronomical community.

Planet Formation Through Radio Eyes

A. Meredith Hughes (Wesleyan Univ.)

Circumstellar disks provide the raw material and initial conditions for planet formation. Millimeter wavelength interferometry is a powerful tool for studying gas and dust in planet-forming regions, and it is undergoing a multiple-order-of-magnitude leap in sophistication with the advent of the ALMA interferometer that is now in the late stages of construction. I will discuss some ways in which millimeter-wavelength interferometry is being used to study the process of planet formation in circumstellar disks, with particular emphasis on the kinematics of turbulence in protoplanetary disks and the degree to which debris disk structure reflects the dynamics of embedded planetary systems.

The First Unbiased Radio Emission Line Survey of the Protoplanetary Disk Orbiting LkCa 15

Kristina M. Punzi (RIT), J. H. Kastner (RIT), P. Hily-Blant (IPAG), T. Forveille (IPAG), G. Sacco (Arcetri Observatory)

We have conducted the first comprehensive mm-wave molecular emission line survey of the circumstellar disk orbiting the nearby pre-main sequence star LkCa 15 (D = 140 pc). The disk around this young (~3-5 Myr) solar analog appears to have a planetary-mass companion (LkCa 15b) within its central cavity. The outer disk is chemically rich, with numerous previous detections of molecular emission lines revealing a significant gas mass. Hence, LkCa 15 is an excellent target for an unbiased radio spectroscopic survey intended to produce a full census of the detectable molecular species within an evolved, protoplanetary disk. Here, we present initial results from our survey of LkCa 15, which was conducted with the Institute de Radioastronomie Millimétrique (IRAM) 30 meter telescope over the 1.3 mm waveband.

This research is supported by National Science Foundation grant AST-1108950 to RIT.

Session II:

Water, Formaldehyde, and Formic Acid Vapors in Spitzer-IRS Spectra of Protoplanetary Disks

Benjamin Sargent (RIT; STScI), W. Forrest, D. M. Watson (Univ. of Rochester), P. d'Alessio (Centro de Radioastronomía y Astrofísica, UNAM), N. Calvet (Univ. of Michigan), E. Furlan (NOAO; Visitor at IPAC), K.-H. Kim (Univ. of Rochester; Korea Astronomy and SpSciInst), J. Green (Univ. of Texas), K. Pontoppidan (STScI), I. Richter (Univ. of Rochester), C. Tayrien (Univ. of Rochester; RIT)

We present spectra of 13 T Tauri stars in the Taurus-Auriga star-forming region showing emission in Spitzer Space Telescope Infrared Spectrograph (IRS) 5-7.5 micron spectra from water vapor and absorption from other gases in these stars' protoplanetary disks. Seven stars' spectra show an emission feature at 6.6 microns due to the $\nu_2 = 1 \sum 0$ bending mode of water vapor, with the shape of the spectrum suggesting water vapor temperatures >500 K, though some of these spectra also show indications of an absorption band, likely from another molecule. The other 6 of the 13 stars have spectra showing a strong absorption band, peaking in strength at 5.6-5.7 microns, which for some is consistent with gaseous formaldehyde (H_2CO) and for others is consistent with formic acid (HCOOH). There are indications that some of these six stars may also have weak water vapor emission. Modeling of these stars' spectra suggests these gases are present in the inner few AU of their host disks, consistent with recent studies of infrared spectra showing gas in protoplanetary disks.

The Unusual Eclipser of the Young Star J1407: Moon-forming Circumplanetary Disk? Extrasolar Ring System?

Eric Mamajek (Univ. of Rochester)

I'll discuss the recently discovered eclipsing system J1407, a 16 million-year-old member of the nearest OB association (Mamajek et al. 2012, AJ, 143, 72). J1407 exhibited an unusual, complex, and deep sequence of eclipses over a 52-day period in 2007 which has thus far not repeated. The eclipsing object appears to be a geometrically thin set of rings girding a slightly denser inner disk probably associated with a substellar object. The rings show evidence for clean gaps of low optical depth between them, suggesting that even smaller bodies have dynamically sculpted them. The scale and inferred mass of the debris ring system are suggestive of what might be expected of a proto-satellite disk in late stages of evolution orbiting a young giant planet. I'll discuss follow-up observations of this system which are helping constrain the mass of the ringed companion to J1407.

Mapping Starspots on Transiting Planet Host Stars

Leslie Hebb (Hobart and William Smith Colleges), J. R. A. Davenport, S. L. Hawley (Univ. of Washington), M. M. Jardine, J. Llama (Univ. of St Andrews)

High precision, near-continuous time series photometry is now available in the Kepler satellite archive for large numbers of transiting planet host stars. Applying a novel technique to Kepler's short cadence light curves of transiting planet host stars with sub-millimag photometric precision we are now, for the first time, able to map relative brightness variations due to individual starspots and starspot groups on the surfaces of stars other than the Sun. Here, we present a new project whose goal is to derive the detailed time evolution of the small-scale starspot distribution on the surface of tens of stars with a range of masses and rotation rates. We have developed new software designed to model brightness variations during planetary transits caused by the planet crossing in front of a starspot on the stellar surface. Our "eclipse mapping" code uses the precise knowledge of the planet's position and comprehensively models the in- and out- of transit data to strengthen the constraints on the positions of the surface spots. Here, we describe our overall project, explain our eclipse mapping technique in detail, and present preliminary results on the transiting planet host star, Kepler-17.

Session III:

A Revised Age for Upper Scorpius and the Star Formation History Among the F-type Members of the Scorpius-Centaurus OB Associations

Mark Pecaut, Eric E. Mamajek (Univ. of Rochester), Eric J. Bubar (Marymount University)

We present a study of the star-formation history and accretion disk fraction of ~0.6-1.8 M_{sun} stars in the nearest OB association, Scorpius-Centaurus (Sco-Cen; ~10-20 Myr; 100-200 pc). We have performed a low-resolution spectroscopic survey for new, low-mass K-and M-type members of all three subgroups -- Upper Scorpius (US), Upper Centaurus-Lupus (UCL) and Lower Centaurus-Crux (LCC). We find that young, pre-main sequence stars are generally redder and hotter for a given spectral type than their main-sequence counterparts and therefore main-sequence intrinsic colors and temperatures are unsuitable for de-reddening the low-mass members of Sco-Cen and placing them on an H-R diagram. Using nearby, young moving groups within 75 pc, we derive a spectral type--intrinsic color sequence appropriate for pre-main sequence stars, and use synthetic spectral energy distribution fits to infer the proper temperature scale for these young stars. We use this new pre-main sequence intrinsic color and temperature calibration to place our ~200 newly identified members of Sco-Cen on an H-R diagram. We derive isochronal ages for the F-type members of Upper Centaurus-Lupus (UCL; 16 Myr; <d>=142 pc) and Lower Centaurus-Crux (LCC; 17 Myr; <d>=118 pc) which are consistent with the most recent results from the high-mass stars and the G- and K-type stars. However, our results for Upper Scorpius (US; 11 Myr; <d>=145 pc) indicate it is a factor of two older than previously thought. Finally, we find an accretion disk fraction for UCL and LCC of ~3% for K-type stars decreasing to 2% for F-type stars at ~16-17 Myr, while US has an accretion disk fraction of 5% for K-type stars decreasing to <19% (95% C.L.) for F-type stars at ~11 Myr.

How Cool Is That? An IRTF/SPEX Spectroscopic Study of the Close Binary T Tauri System V4046 Sgr

V. Rapson (RIT), C.T. Smith (RIT/UA), B. Sargent (RIT), J Kastner (RIT), J. Rayner (IRTF)

We have obtained near-IR (1-5 micron) spectroscopy of the nearby, close binary T Tauri system V4046 Sgr AB with the NASA Infrared Telescope Facility (IRTF) SPEX spectrometer. Our motivation is to assess the potential discrepancies between optical and near-IR spectral classifications of this and other young, late-type stars. Such (optical vs. near-IR) spectral type discrepancies have important implications for the application of pre-main sequence (pre-MS) evolutionary tracks to infer the ages and masses of pre-MS stars; V4046 Sgr AB provides an important test case in this regard, due to the stringent constraints on its system mass (a total of ~1.8 M_{sun}, with roughly equal-mass components) that are imposed by interferometic CO imaging of its extended circumbinary disk combined with its relatively well-determined age (~12 Myr) and distance (~73 pc). We performed equivalent width measurements of diagnostic absorption lines and broad scaling relation measurements to facilitate comparisons between our SPEX near-IR observations and those of IRTF spectral standards. Our preliminary results point to a composite near-IR spectral type for V4046 Sgr AB that is later than the (mid-K) type previously determined from optical spectroscopy. This discrepancy is consistent with that found for other T Tauri stars (most notably, for TW Hya), emphasizing the need for caution in relying on a specific wavelength regime to obtain pre-MS stellar spectral classifications and (hence) determinations of pre-MS age and mass.

LAMOST Observations of Substructure in Bulk Velocities of Milky Way Disk Stars

Jeffrey L. Carlin (RPI), James DeLaunay (RPI, Penn St. Univ.), Heidi J. Newberg (RPI), Licai Deng (National Astronomical Observatories, Chinese Acad. of Sciences), Daniel Gole (SUNY-Geneseo, Univ. of Colorado), Kathleen Grabowski (RPI), Chao Liu (National Astronomical Observatories, Chinese Acad. of Sciences)

We explore the kinematics of ~400,000 F-type stars in the Galactic disk and just outside the Sun's radius using data from the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) survey. LAMOST spectroscopic velocities were combined with proper motions from the PPMXL catalog, for which we have derived corrections to the zero points based in part on spectroscopically discovered galaxies and QSOs from LAMOST, to derive three-dimensional space velocities for the stellar sample. Stars near the Galactic anticenter exhibit velocity substructures in both the Galactocentric radial and vertical components. The structure is most prominent as an asymmetry across the mid-plane, but also varies azimuthally. In the region within 2 kpc outside the Sun's radius and within 2 kpc of the Galactic midplane, stars above the plane exhibit net outward radial motions with downward vertical velocities, while stars below the plane have roughly the opposite behavior. This is likely the signature of perturbations to the disk by an external agent such as a dwarf galaxy or dark matter subhalo.

Session IV:

The Labors of Hercules A: Trying to Make Sense of a Complicated Radio Galaxy

Chris O'Dea (RIT)

We present Hubble optical, VLA radio, and Chandra X-ray observations of the radio galaxy Hercules A (3C 348). The radio jets/lobes on the opposite sides of the source have very different properties. We find a network of dusty filaments which are more complex and extended than seen in earlier Hubble Space Telescope (HST) observations. The filaments are associated with a faint blue continuum light (possibly from young stars) and faint Hα emission. It seems likely that the cold gas and dust has been stripped from a companion galaxy now seen as a secondary nucleus. There are dusty filaments aligned with the base of the jets on both eastern and western sides of the galaxy. The morphology of the filaments is different on the two sides—the western filaments are fairly straight, while the eastern filaments are mainly in two loop-like structures. We suggest that despite the difference in morphologies, both sets of filaments have been entrained in a slow-moving boundary layer outside the relativistic flow. We have discovered an X-ray jet associated with the Eastern side which may be due to synchrotron radiation from particles accelerated during the deceleration/disruption of the jet. We consider a speculative scenario to explain the relation between the radio source and the shock and cavities in the hot intracluster medium seen in the Chandra data. We suggest that the radio source originally (~60 Myr ago) propagated along a position angle of ~35° where it created the shock and cavities. The radio source axis changed to its current orientation (~100°) possibly due to a supermassive black hole merger and began its current epoch of activity about 20 Myr ago.

The Covering Factor of the Dense Circumgalactic Medium in the COSMOS Field at z < 1

Joseph Ribaudo (Utica College), Nicolas Lehner, J. Christopher Howk (Univ. of Notre Dame)

Understanding the origins and physical distribution of the extended gaseous environments of galaxies, known as the circumgalactic medium (CGM), is critical in determining how the circulation of gas impacts the formation and evolution of galactic structures over cosmic time. To investigate the distribution of dense gas around galaxies we estimate the covering factor of the CGM of galaxies probed by optically-thick H I absorbers in the COSMOS field. Using UV spectroscopy of 27 QSOs observed with GALEX, combined with deep HST imaging and ground based observations of the galaxies in the QSO fields, we find the covering factor of the optically-thick CGM is less than unity at small impact parameters (< 25 kpc) and drops considerably to < 10% at 200 kpc. The sample of galaxies within the COSMOS field that do not give rise to an optically-thick absorption signature also place significant constraints on the composition and distribution of the CGM at z<1.

Discovery of Misaligned Radio Emission in Galaxy Cluster Zw CL 2971

Nicole Wallack (Univ. at Albany), Dr. Charles Liu (Amer. Museum of Natural History and CUNY College of Staten Island)

In a search for green valley galaxies with radio loud active galactic nuclei (AGN), we found one such object that may be associated with the cluster of galaxies Zw CL 2971 (z = 0.098). Serendipitously, we found in this cluster a strong bent-jet radio source associated with the cluster's central dominant (cD) elliptical galaxy. The center of the cD galaxy is coincident (0.35 arcsecond) with the second brightest spot of radio continuum emission (34.3 mJy as measured by FIRST), but the brightest radio hotspot (66.8 mJy) is offset by 4.6 arcseconds (~9 kpc at the redshift of the cluster) and has no visible counterpart. Furthermore, the optical spectrum of the cD galaxy has only weak emission lines, suggesting the absence of a currently active nucleus. It is possible that the counterpart is optically faint (possibly due to a recently completed duty cycle) or is not visible due to movement or position. If the radio source is a distant background object, then the brighter jet is most likely magnified by gravitational lensing. If the radio source is located at the redshift of the cluster, then the brighter radio jet trails backward toward and past the cD galaxy to a distance of ~120 kpc, while the fainter jet is bent at a nearly orthogonal angle, ~40 kpc away from the brightest radio hotspot, in the opposite direction. These geometric offsets could be used to constrain the duty cycle history of the AGN creating the radio emission, as well as the dynamical properties of the intracluster medium.

Posters:

Molecular Line Surveys of Nearby T Tauri Stars: Late-Time Chemistry of Protoplanetary Disks

Joel Kastner, Kristina Punzi (RIT), David Rodriguez (Universidad de Chile), Germano G. Sacco (Arcetri Observatory), Pierre Hily-Blant, Thierry Forveille (IPAG), Ben Zuckerman (UCLA)

We have conducted mm-wave molecular line surveys of the evolved, irradiated circumstellar disks orbiting the nearby, roughly solar-mass, pre-main sequence (T Tauri) stars TW Hya, V4046 Sgr, T Cha, and LkCa 15. All four are transition disk systems with relatively advanced ages (5-12 Myr), yet display spectral signatures of ongoing stellar accretion. Our radio spectral line surveys were performed with the APEX 12 meter and IRAM 30 meter telescopes. In the cases of the TW Hya, V4046 Sgr, and LkCa 15 disks -- all of which are known to retain significant residual gaseous components, as evidenced by previous radio and infrared detections of molecular and atomic emission lines -- we performed unbiased broad-band observations intended to yield a complete census of bright mm-wave emission lines. Initial results from these survey data include first-time detections of the molecules CCH and CS in TW Hya and V4046 Sgr, as well as complete coverage of hyperfine transitions of CN and CCH (in all three disks). In the case of T Cha, we have obtained the first direct detection of its rotating, gaseous disk, in the form of double-peaked emission lines of CO and lines of HCN, CN, and HCO+. Our line survey results thereby provide new constraints on models describing late-stage disk protoplanetary gas dissipation and chemical evolution, and point out future directions for ALMA imaging of these and other, similarly resolvable T Tauri star disks.

Investigations of Magnetic Activity Across YSO Classes: Multiwavelength Observations of the Star-forming Regions L1630 and L1622

David Principe (RIT), Germano Sacco (INAF-Osservatorio Astrofisico di Arcetri), Joel Kastner (RIT).

The role of magnetic fields in star formation is presently the subject of intense debate. A combination of X-ray and infrared/submm observations of young stellar objects (YSOs) in active regions of star formation can elucidate the presence and strength of magnetic fields and the likely influence of such fields on protostellar collapse and the formation of circumstellar disks. Here, we present combined Chandra X-ray, Submillimeter Array (SMA), and archival infrared observations of L1630 and L1622, two particularly diverse star-forming regions in Orion. We have characterized the X-ray activity of dozens of YSOs in L1630, and conducted an SMA continuum and line imaging study to determine the submillimeter emission properties of X-ray-emitting YSOs in selected regions of the cloud. We have also established the association of X-ray activity and SMA continuum sources with the components of the HBC 515 multiple system in L1622. This system is composed of a very young (age < 1 Myr) intermediate-mass (∼2 Solar mass) binary, which evidently has already dissipated its circumstellar disk; a low-mass protostar surrounded by a thick envelope of gas and dust; and two more widely separated, low-mass, pre-main sequence stars. It is hence an excellent system for testing various theories describing disk dispersal and multiple system interaction in the early stages of the star formation process.

Stellar Evolution Modeling with the MESA code

Jonathan Strumpf, Eric E. Mamajek (Univ. of Rochester)

Many interesting and important stellar properties are dependent on accurate stellar ages, and yet the ages of stars are one of the most challenging parameters for astronomers to constrain. We use MESA (Modules for Experiments in Stellar Astrophysics) to create stellar evolution tracks for the purpose of constraining more accurate stellar ages than are currently available. With MESA we create a very fine grid of stellar evolution tracks; the code evolves a star of a given mass through its lifetime and keeps track of important stellar parameters such as effective temperature, luminosity, and age. We created evolutionary tracks using the protosolar abundances given in Asplund et al, 2013 with masses from $0.18M_{sun}$ to $3M_{sun}$ in $0.01M_{sun}$ intervals, $3.0M_{sun}$ to 10.0 M_{sun} in $0.1M_{sun}$ intervals, and from $10.0M_{sun}$ to $30.0M_{sun}$ in $1.0M_{sun}$ intervals. Isochrones, through interpolation, "string" together evolutionary tracks from different masses at points of common age, creating a tool for finding the age of a star from its position on the Hertzsprung-Russell diagram (a graph of Temperature and Luminosity). This grid of masses is finer than those which many published isochrones are interpolated over in an attempt to detail the sublte structure that many be missed in a less dense spread of evolutionary tracks. The completed isochrones offer a tool kit for analyzing stellar ages for many different astronomical studies, one of major focus being an accurate age dating of the nearby OB association, Sco-Cen.

An Analysis of the Substructure of the Scorpius Centaurus OB Association

Molly Finn, Eric Mamajek (Univ. of Rochester)

We present an analysis of the substructure of the Scorpius Centaurus OB Association. After compiling a list of likely members from a wide range of sources, we performed clustering analyses to examine the respective distances between these stars and find how they naturally grouped together using both the k-means and hierarchical, agglomerative clustering algorithms. Through these means, as well as other potential algorithms, we redefine the subgroups of Scorpius Centaurus to better reflect its actual structure.

Kinematic Discovery of a Stellar Stream Located in Pisces

Charles Martin, Jeffrey L. Carlin, Heidi Jo Newberg (RPI), Carl Grillmair (Spitzer Sci Ctr, Caltech)

We report the kinematic discovery of the Pisces Stellar Stream (PSS), at Galactic longitude $l \approx 135^\circ$ and $-39^\circ < b < -36^\circ$. We originally identified this halo substructure from velocities of red giant branch stars in the Sloan Digital Sky Survey (SDSS) Data Release 8, and confirmed its presence in turnoff stars from SDSS photometric data. The PSS is a narrow, kinematically cold tidal stream, with $\sigma_{v,0} \approx 8$ km s^{-1} . Its metallicity is [Fe/H] ≈ −2.2, with ∼0.3 dex dispersion. The color–magnitude signature of the stream turnoff, combined with our measured metallicity, places the PSS at a distance of 35 ± 3 kpc. The PSS is the same as the previously announced "Triangulum stream" and part of the proposed "stream a." We rule out an association of the PSS with other previously known Milky Way substructures in the same region of the sky.

Star Formation in the NGC 5846 Group of Galaxies

Michael Warrener, Ryan Muther, Rebecca Koopmann (Union College)

Star formation distributions of galaxies in the western portion of the NGC 5846 group are determined using broadband R and narrowband Hα images obtained at the KPNO WIYN 0.9m telescope with MOSIAC. Of 28 galaxies in the field, six have Hα emission. Several of these galaxies display star formation that is truncated compared to the stellar extent. The

truncation of star formation and the low detection rate suggest that environmental effects are important in this group.

Population Synthesis of Radio & Gamma Ray Millisecond Pulsars

Sara Frederick (Univ. of Rochester), Peter L. Gonthier (Hope College), Alice K. Harding (NASA Goddard SFC)

In recent years, the number of known millisecond pulsars (MSPs) in the Galactic disk has risen substantially thanks to confirmed detections by *Fermi*. This new population synthesis uses Markov Chain Monte Carlo techniques to explore the large and small worlds of the model parameter space and allows for comparisons of the simulated and detected MSP distributions. The simulation employs empirical radio and gamma-ray luminosity models that are dependent upon the pulsar period and period derivative with freely varying exponents. Parameters associated with the birth distributions are also free to vary. The computer code adjusts the magnitudes of the model luminosities to reproduce the number of MSPs detected by a group of ten radio surveys, thus normalizing the simulation and predicting the MSP birth rates in the Galaxy. Computing many Markov chains leads to establishing preferred sets of model parameters that are further explored through two statistical methods. Marginalized plots define confidence regions in the model parameter space using maximum likelihood methods as well as Kuiper statistics from comparisons of cumulative distributions. These two techniques provide feedback to affirm the results and to check for consistency. We follow an analogous set of assumptions that we have used in previous, more constrained Monte Carlo simulations. In addition, radio flux and dispersion measure constraints have been imposed on the simulated gamma-ray distributions in order to reproduce realistic detection conditions. The simulated and detected distributions agree well for both sets of radio and gamma-ray pulsar characteristics, as evidenced by our various comparisons.

Stellar Photometry of SNR 1E0102.2-7219 in the Small Magellanic Cloud

Chelsea A. Lister (RPI), Jon A. Morse (BoldlyGo Enterprises, LLC)

We provide a study of the field surrounding supernova remnant 1E0102.2-7219 (hereafter E0102) in the Small Magellanic Cloud through stellar photometry. E0102 is a rare oxygen-rich, hydrogen-poor SNR with an uncertain progenitor. Using data observed in 2003 from the ACS Wide Field Camera aboard the HST, we conduct stellar photometry via DAOPHOT II, by Peter Stetson. We create color magnitude diagrams (CMD) based on the F475W, F550M, F775W, and F850LP filters, and compare the results to previous work. It appears our diagrams illustrate an abundance of B stars with little to no O stars on the main sequence. Knowing the age of the surrounding field could provide insight to E0102's progenitor.

Chandra X-Ray Imaging Spectroscopy of the Complex Planetary Nebula NGC 7009

Kayla Emerson (RIT), Rodolfo Montez, (Vanderbilt Univ.), Joel Kastner (RIT)

Planetary nebulae (PNe) are the outer layers ejected and subsequently ionized by dying, post-asymptotic giant branch stars on their way to becoming white dwarfs. These objects are likely shaped by internal wind collisions, and these wind collisions evidently form X-ray emitting "hot bubbles" in some young PNe. X-ray observations of a PN can be used to infer chemical composition, hydrogen column density to and within the PN, and pressure in the hot bubble, so as to investigate its origin and evolution. To further study X-ray emission from PNe, an international group of astronomers has undertaken the Chandra Planetary Nebulae Survey (ChanPlaNS), a multicycle Chandra X-ray Observatory (CXO) Large Program, to survey nearby ($D < 1.5$ kpc) PNe. NGC 7009, the Saturn Nebula, is one of the more structurally complex PNe observed thus far during ChanPlaNS: it displays an elliptical, X-ray luminous hot bubble and bullet-like ejecta nested within a larger, optical/infrared emissihon halo. We present preliminary results from ChanPlaNS X-ray observations of NGC 7009, including comparison of CXO and Hubble Space Telescope images and inferences into hot bubble plasma physical conditions as deduced from spectral model fitting.

Testing the Caustic Ring Dark Matter Theory Against Observations in the Milky Way

Julie Dumas (RPI)

We test a particular theory of dark matter, in which dark matter axions form ring "caustics" in the plane of the Milky Way. According to this theory, cold collisionless dark matter particles with angular momentum flow in and out of the Milky Way as it forms. These flows form caustic rings (at the positions of the rings, the density of the flow is infinite) at the locations of closest approach to the Galactic center. We show that the caustic ring dark matter theory reproduces a roughly logarithmic halo, with large perturbations near the rings. We show that the theory can reasonably match the known Galaxy rotation curve. We explore the effects of the caustic rings on dwarf galaxy tidal disruption using N-body simulations. Tidally disrupted galaxies are stripped apart by the gravitational forces of the Milky Way, leaving both leading and trailing streams of stars. We compare the results of the model with observations of tidal streams.