NEW YORK - CITY OF STARS

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Abstract

The challenges and opportunities of observing variable stars from New York City are described.

1. Introduction

It is commonly asserted that urban zones are not suitable for valid astronomical work. New York City is often cited as the epitome of astronomy-hostile cities. Astronomers living in cities typically have no handy yards or fields, few cars or vans, tiny apartments, illuminated skies, and limited prospect on the stars.

They may have only portable telescopes or binoculars from the lack of room to store, or a place to use, a conventional large rig. With no car, for its expense and trouble in the city, they cannot easily go to a dark site or carry loads of gear.

While these factors can work against many astronomy studies, they hardly impede the study of variable stars. In New York City there are an amazing number and variety of accessible variable stars that are important, interesting, bright, and well distributed on the sky. Based on the roster of AAVSO stars, there is available from New York City a healthy sampling of virtually every category of star. They offer a truly worthwhile career to the urban astronomer, observing from city flats far away from open fields and dark skies, and using small telescopes or binoculars, AAVSO charts, and a notebook.

2. The City Variable Star File

The AAVSO maintains a roster of variable stars in its visual program. This file contains about 3,600 stars of different brightnesses and descriptions. This roster is not at all a general catalogue of variables. Indeed, many bright and noted variables, like Polaris and Algol, are not included. From this file was extracted a set of stars suitable for city astronomers: the city variable file, or "cityfile".

Given the generally small aperture of the city astronomer's instruments, the city variable star must be bright. Based on experiences in New York City, a star should be at least magnitude 8.0 at maximum to be comfortably discernible in binoculars or portable telescopes. Also, the star should be 8th magnitude at maximum to be visible over a satisfying part of its light curve, if not the entire light curve, in the typical city astronomer's instrument.

Hence, the first slice out of the AAVSO roster was made for all stars with maxima brighter than magnitude 8.0. The second slice removed two particular categories of star as being unsuitable for city observers. These are the constants and the novae. Novae typically erupt only once to a bright maximum and thereafter remain near their deep minimum. Constants were once deemed to be variable but are now believed to be stable in light, as determined by continued monitoring.

The final "cityfile" has 457 stars over all the sky. Of these, 375 are visible from the latitude of New York City (or southern Europe). The extraction and subsequent massaging of the "cityfile" was done with *Lotus 123* and *HAL* on an IBM-XT. The AAVSO roster was imported into 123 as a text file, parsed, and then worked on as a .WK1 file.

This "cityfile" is available from the author as either a hard copy (printout) or an IBM 5-1/4-inch 360k disc. In both cases the layout is that of the AAVSO original master file and the format is pure ASCII text.

3. The Brightness of City Variables

The "cityfile" stars can be observed at least in the maximum phases of their light curves. The larger the telescope at hand, the farther toward minimum a star can be monitored. Based on experience in New York City, a 100-mm telescope is about as large as can be maneuvered in an apartment, taken to a rooftop or terrace, or carried on public transport.

Although a 100-mm telescope can reach to magnitude 12.7 according the usual formula for threshold magnitude, 12.0 is more realistic for comfortable sighting of the star near minimum and to accommodate light-veiling effects. This is, in effect, a doubling of the light-flux limit. (Note that a light-veiled sky is diluted under magnification into darkness, while the star's image remains a point.)

In the "cityfile", 348 stars have minima above magnitude 12.0 and these are observable from the city over their entire cycles of light variation. New York City by virtue of its latitude, sees 290 of these variables. The stars eliminated from this total are those with minima below 12th magnitude or with no cited minima at all.

4. The Number of City Variables

The "cityfile" contains 457 stars. These 457 stars, over the whole sky, are barely 13% of the full roster, a seemingly small portion. Yet this number is quite comparable to the number of asteroids, star clusters, or binaries in the observing scheme of a typical amateur astronomer.

New York City sees 375 of the stars in the "cityfile". Its latitude of 40°N implies a southern declination limit of 50°S. However, the far southern stars do not get above a tall skyline and dense horizon air. A limit of 30°S is used to select New York City's 375 stars.

At best, an urban astronomer in New York City can observe a different variable each night for a year without duplication. In practicality, virtually all the variables demand repeated estimates throughout the year. Also, given the burden of New York City's weather and urban life, perhaps 90 nights of the year are actually usable and free for observing.

5. The Distribution of City Variables

The stars in the "cityfile" are well distributed around the sky; there are no "dead zones" where the city astronomer has no or few stars to observe.

Considering sectors of right ascension around the sky, there are 19 variables per hour of Right Ascension (RA), on the average. For New York City, due to latitude effects, there are 16 per hour. To be fair, there is some bunching along the Milky Way, but not enough to leave empty any large section of the sky. Even the poorest RA sector has six city variables and all six are visible from New York.

If the urban astronomer has only a fixed view of the sky, as through a window or

between tall towers, the stars passing through that view sit in one belt of declination. Taking 15° declination bands from pole to pole, there is consistently one variable per 100 square degrees. Two belts have two per 100 square degrees. (Only the south polar zone has no variables in it.)

This means that whatever the season, the hour, or the view of the sky, the city observer can expect to find at least one variable in any box of sky 10 degrees square. In the Milky Way regions this density rises to two per 10-degree box and in the poorest areas it is about one per 15-degree box.

6. The Categories of City Variables

Despite the small portion of the AAVSO roster that comprises the "cityfile", this file contains variables of real importance and interest to astronomy. The stars in the "cityfile" call for continual monitoring, sometimes desperately so. Table 1 shows the stars in each major category.

Table 1. Categories of "cityfile" variables in AAVSO visual observing program.

	Numbers of Variables in Whole Sphere		Number of Variables in New York Sky	
Type	*All*	*Brighter than 12 m*	*All*	*Brighter than 12 m*
Cepheid	69	69	43	43
Eclipsing	8	8	7	7
gamma Cas	18	18	18	18
Medium irregular	12	12	10	10
Slow irregular	50	49	45	44
Mira	81	27	57	19
Semiregular	108	106	96	94
Uncertain	87	40	79	39
Other*	24	19	20	16
Total	457	348	375	290

* Twelve types combined, each with fewer than five specimens

In virtually all types there is a large selection of specimens to observe. Furthermore, the majority of stars are observable throughout their light variations. The prime exception is the Mira (o Ceti) type. This type has an enormous range that often brings the star below the 12th magnitude limit. However, their continuous activity and ample portion of light curve that remains within range from the city makes them especially favorable for the urban astronomer.

It also turns out that the Mira stars for the urban observer enjoy a remarkable additional favor. They are among the Mira stars in the observing program of the HIPPARCOS satellite! These stars require special attention so that their brightness may be properly anticipated as they come up in HIPPARCOS' observing schedule.

Note that many of the uncertain type of variables are eliminated from the "Brighter than 12 ^{m}" column because they have only a maximum on record; the minimum is blank.

7. The Orion Nebula, a Nest of City Variables

One place in the heavens teeming with city variables is not incorporated in the facts and figures of this paper. This is the Orion Nebula. Due to the essential absence of stable comparison stars among the variables in the Nebula, special observational methods are required and the AAVSO treats the Nebula separately from its regular roster of variable stars.

The Orion Nebula harbors a hundred variables, all in constant luminous agitation. Some 30, if gauged against the criteria of the "cityfile", qualify as city variables. That is, they are bright and interesting. Moreover, because they sit near the celestial equator, they are observable from urban sites of all latitudes.

The only discouragement to city astronomers — apart from the nonstandard estimating techniques required — is the necessity for a telescope. The Orion Nebula stars are concentrated in a two-degree zone around the Nebula and cannot be resolved clearly in hand-held binoculars. However, any portable telescope operating at 100 power can separate the stars of the nebula region and enable the urban astronomer to observe them individually.

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