New Horizons LEISA Pluto Encounter Calibrated Data Overview

During the migration to the Planetary Data System's (PDS) PDS4 data standards, this current description was adapted from the PDS3 dataset catalog file, including updates found in the KEM1 Encounter phase version, providing light edits to the text, format, flow, and to make the description to better conform to this PDS4 data collection.

Abstract

This data set contains Calibrated data taken by the New Horizons Linear Etalon Imaging Spectral Array (LEISA) instrument during the PLUTO ENCOUNTER mission phase.

This data set contains LEISA observations taken during the Approach (Jan-Jul, 2015), Encounter, Departure, and Transition mission sub-phases, including flyby observations taken on 14 July, 2015, and departure and calibration data through late October, 2016. This data set completes the Pluto mission phase deliveries for LEISA.

Changes since prior versions include the addition of data downlinked between the end of January, 2016 and the end of October, 2016, completing the delivery of all data covering the Pluto Encounter and subsequent Calibration Campaign. It includes multi-map observations from the Approach phase, observations of the moons, and hi-res departure observations. It also includes functional tests from the Calibration Campaign including scans across the detector of Arcturus, and a second test of the Solar Illumination Assembly.

The data were re-run through the pipeline, which changes the FITS headers of the raw files, but not the FITS data. The exceptions to that are products for which only sub-frame windows were downlinked in previous versions of this data set: those products have been re-downlinked either in full, or all regions outside the previously downloaded windows were downloaded and merged to form full-frame products. In so doing, some LEISA products have more frames downloaded, resulting in a change in the number of frames listed in the PDS labels. Finally, the updated calibration files cause changes to all of the calibrated data.

These data were migrated from the previously released PDS3 data set NH-P-LEISA-3-PLUTO-V3.0.

Data Set Overview

This data set contains Calibrated data taken by the New Horizons Linear Etalon Imaging Spectral Array (LEISA) instrument during the PLUTO ENCOUNTER mission phase. The closest approach to Pluto occurred on July 14, 2015, at approximately 11:50 UTC.

LEISA is an infrared imaging spectrometer. The two-dimensional (2-D) detector is a 256x256-pixel array. Spectral separation is done with a wedged optical etalon filter, which comprises high (2.1-2.25 micron) and low (1.25-2.5 micron) spectral resolution segments. The optics and

filter arrangement configure one detector dimension as spatial at constant wavelength and the other dimension as both spectral and spatial. Multiple frames (images) may be taken in sequence, while scanning the Field Of View (FOV) in the spatial+spectral dimension, such that each pixel-sized piece of the observed target will be observed at all wavelengths across multiple frames. The resulting data products in this data set are three-dimensional image cubes, which dimensions are spatial, spatial+spectral, and spatial+time and which shall be convolved into spatial, spatial, and spectral image cubes at a later date.

During the Pluto-Charon Encounter mission phase starting in January, 2015, there were several sub-phases: three Approach sub-phases, (AP1, AP2 and AP3); a CORE sequence around the Pluto flyby on 14.July, 2015 (Day Of Year 195), sometimes also referred to as NEP (Near-Encounter Phase); three Departure sub-phases (DP1, DP2, DP3); a Transition sub-phase closing out the Pluto Encounter mission phase ending in late October, 2016 (mission phase definitions are 'soft'; for details refer to the New Horizons Mission Overview document, PDS4 LID `urn:nasa:pds:nh_documents:mission:nh_mission_overview`). For this final Ralph-LEISA delivery for this Pluto-Charon Encounter mission phase, this data set includes all Approach, CORE, Departure, and Transition data downlinked through the end of October, 2016.

On Approach during April, May and June of 2015, LEISA operations included the following: functional tests including a scan test; and observations of Pluto, Charon and the other Plutonian satellites.

This dataset includes the first 3 P-LEISA scans of Pluto taken at 28, 26, and 24 days before the Pluto closest approach, to look for changes in surface color and composition over multiple rotations. It also includes three of the PC_VISUV_MAP observations at 18, 17, and 15 days before encounter, with the same goal as P-LEISA. At 13 days, PC_LEISA_VAR looks at the IR variability of Pluto and Charon.

The dataset also has a series of PC_MULTI_MAP observations, from 11 days and 2 days before closest approach. The PC_MULTI_MAPs met multiple objectives as measurements coordinated with the P-Alice, LORRI, and MVIC instruments. For LEISA, these objectives included determining Pluto and Charon phase integrals, as LEISA offers another alternative to visible wavelength imaging to get the angular dependence of scattering by Pluto. They also are the primary method of performing global temperature mapping of Pluto's surface ices, based on LEISA near-IR spectral-imaging. The measurements support further goals for IR spectroscopic maps of Pluto and Charon, searching for changes over multiple rotations, looking at the composition of low albedo areas of Pluto, and investigating the composition of non-encounter hemispheres of Pluto and Charon. Also, using LEISA to observe various regions of Pluto at or near the approach and departure asymptote phase angles supports the determination of the bolometric albedos of various regions. Finally, LEISA spectral studies of Pluto at multiple phase angles helps to learn about surface processing and structure in various regions.

This LEISA dataset also has 2 observations on the day of closest approach: (1) P_LEISA_Alice_1a, which is a backup for scans of whole disk at 7-10 km/pix to get a global infrared spectral map of Pluto; and (2) C_LEISA_LORRI_1, which gives the Charon resolved IR surface map and phase

integral, and spectral studies of Charon at multiple phase angles to learn about surface processing and structure in various regions. Both also fulfill the objectives of the MULTI_MAPs.

You can quickly find all these mentioned observations (PC_VISUV_MAP, PC_MULTI_MAP, P_LEISA_Alice_1a, etc) by searching the <nh:sequence_id> keyword values within the data labels.

This final delivery also has the remainder of the encounter multi-maps and other Pluto system observations, including full-frame versions of images for which only windows were downlinked in past deliveries.

From the Transition sequence there are functional tests and star calibrations, taken in mid-2016.

Note that the smaller satellites of Pluto, Kerberos and Styx, were not directly observed by LEISA. Although there may be observations with those smaller satellites in the background, identifying such observations is beyond the scope of this delivery; the user is referred to the New Horizons NAIF/SPICE data set (https://doi.org/10.17189/1520109) to calculate the location of any objects possibly within the fields of view of any observations.

Note that, in many Pluto data sets, there will be windowed products, but the targeted object may or may not be visible in the downlinked window in any given frame.

Every observation provided in this data set was taken as a part of a particular sequence. For this data set, these sequences can be found in the Ralph document collection under PDS4 LID `urn:nasa:pds:nh_documents:ralph:seq_leisa_pluto`. Please note that some sequences provided may have zero corresponding observations.

Version History

Each subsection below details the major changes between the prior versions of this data set, listing the newest versions before older versions.

PDS4 v1.0 (migration from PDS3 V3.0)

This data collection was migrated from Planetary Data System's (PDS) PDS3 archive standards to the PDS4 archive standards, which involved changing the PDS formatted product labels. The products themselves have remained unchanged. The major changes from the PDS3 V3.0 data set are:

- the calibration files, documents, and data products were reorganized into separate collections of calibration files, documents, and data products, instead of being in a single package as it was in prior PDS3 data set versions.
- the geometry keyword values found within the PDS4 labels were calculated using the most recent SPICE kernels available at label creation. Note that the FITS headers have not been updated and their geometry keyword values therefore remain unchanged.

- the PDS4 data labels were produced using the PDS3 data labels and/or FITS headers, and so any fixes and/or updates to the PDS3 label pipeline as found in future mission phases may not have been implemented here.

PDS3 V3.0 (NH-P-LEISA-3-PLUTO-V3.0)

This is VERSION 3.0 of this data set. This P3 Pluto Encounter dataset release includes all data from the previous two Pluto deliveries and adds data that was downlinked from 1/31/2016 through 10/31/2016. This dataset completes delivery of all data covering the Pluto Encounter and subsequent Calibration Campaign.

Also, updates were made to the calibration files, documentation, and catalog files. The data were re-run through the pipeline, which changes the FITS headers of the raw files, but not the FITS data. The exceptions to that are products for which only sub-frame windows were downlinked in previous versions of this data set: those products have been re-downlinked either in full, or all regions outside the previously downloaded windows were downloaded and merged to form full-frame products. In so doing, some LEISA products have more frames downloaded, resulting in a change in the number of frames listed in the PDS labels. Finally, the updated calibration files will change all of the calibrated data.

As of V3.0, targets for some stars and radio sources have been updated so that the TARGET_NAME keyword in the label is accurate and more descriptive than only STAR or CALIBRATION. However, the user should confirm that targets from the data FITS files, if applicable for a given instrument, match the label name, as there are a few instances where the FITS keywords for TARGET, SPCCBTNM, and PNTMTHD are not accurate. The simplest way to check is to instead look at the RA and Dec in the keywords SPCBRRA and SPCBRDEC in the FITS file. This issue mostly only occurs with star targets.

PDS Citation Information: Stern, A., NEW HORIZONS CALIBRATED LEISA PLUTO ENCOUNTER V3.0, NH-P-LEISA-3-PLUTO-V3.0, NASA Planetary Data System, 2018.

PDS3 V2.0 (NH-P-LEISA-3-PLUTO-V2.0)

This is VERSION 2.0 of this data set. This P2 Pluto Encounter dataset release provides updates to the Pluto dataset between P1 (data on the ground by 7/31/2015) and P2 (data on the ground by 1/31/2016). All liens from the initial Pluto delivery have also now been resolved. Two digits of precision have also been added to the EXPOSURE_DURATION value in all data labels after V1.0.

PDS Citation Information: Stern, A., NEW HORIZONS CALIBRATED LEISA PLUTO ENCOUNTER V2.0, NH-P-LEISA-3-PLUTO-V2.0, NASA Planetary Data System, 2016.

PDS3 V1.0 (NH-P-LEISA-3-PLUTO-V1.0)

This is VERSION 1.0 of this data set. For this first Ralph-LEISA delivery for the Pluto mission phase, this data set includes only the Approach data plus the subset of the CORE sequence data that was downlinked through the end of July, 2015. Liens were never resolved for this data set version, but will be in the next version.

Citation Information: Stern, A., NEW HORIZONS CALIBRATED LEISA PLUTO ENCOUNTER V1.0, NH-P-LEISA-3-PLUTO-V1.0, NASA Planetary Data System, 2016.

General statement about data set versions after V1.0

The pipeline (see Processing below) was re-run on these data for each version since the first (V1.0). A pipeline rerun usually changes the FITS headers but not the FITS data of raw data sets. In some cases, calibrated FITS data may change because the calculated geometry of an observation has changed. See data set version-specific sections above for significant exceptions to this general statement, i.e., changes to pipeline processing, calibration processing, and data delivered.

An all-instrument Calibration Campaign occurred in July 2016. For most instruments, calibrations were updated as of April 2017 which changed the data in the calibrated data sets. Calibration changes are described in the data set version-specific sections.

Note that even if this is not a calibrated data set, calibration changes are listed as the data will have been re-run and there will be updates to the calibration files, to the documentation and to the steps required to calibrate the data.

Processing

The data in this data set were created by a software data processing pipeline on the Science Operations Center (SOC) at the Southwest Research Institute (SwRI), Department of Space Operations. This SOC pipeline assembled data as FITS files from raw telemetry packets sent down by the spacecraft and populated the data labels with housekeeping and engineering values, and computed geometry parameters using SPICE kernels. The pipeline did not resample the data.

Calibration

Detailed information about calibration of LEISA data is available in the SOC Instrument Interface Control Document (ICD) within the PDS (PDS4 LID `urn:nasa:pds:nh_documents:mission:soc_inst_icd`). The LEISA calibration will only be briefly summarized here; refer to the ICD for details about what is summarized here.

The calibration of LEISA images comprises the following steps:

1) Remove electronics-induced and flat-field signal
2) Apply calibration offset and gain
3) Adjust for integration time, filter width, and pixel solid angle
4) Correct for gain

In addition, the calibration procedure calculates various quantities such as error (see note below) and a data quality flag for each pixel and includes those results in the calibrated data product as additional PDS OBJECTs (FITS extensions) appended to the main OBJECT with the data image. The quality flag PDS OBJECT is an image of values of the same size as the main IMAGE product, with each quality flag pixel mapped to the corresponding pixel in the main

product. A quality flag value of zero indicates a valid pixel; a non-zero value indicates an invalid pixel.

Note that for windowed products, all pixels in an image are not returned in the downlink telemetry. In the raw data, the pipeline sets such pixels to zero DN (Data Number); the calibration processes those zero-DN pixels as if they were real raw values may result in a confusing result with the majority of the displayed image appearing as an inverse of the calibration (calibration of zero values); therefore the windowed status of the image, as recorded in the value for the NOTE keyword of the PDS label should be considered when looking at these data.

Calibration and data characteristics

i) Error estimates are all zero. As of late 2016, the code to calculate the values for the Error estimates extension has not been deployed to the SOC, and placeholder code sets all pixel error estimates to zero. When the updated code is deployed to the SOC, some reprocessed observations may be delivered to PDS (e.g. Jupiter encounter data); note that observations from the Launch and Pluto Cruise mission phases have little if any science utility, so there is no incentive to reprocess those data just to provide error estimates.
ii) Fixed-pattern noise. There is usually fixed-pattern noise (FPN) in the data that cannot be removed by the flat-field correction. Users need to generate an average of a few run-up frames containing background sky and the FPN, and subtract that average from every frame with a target source present. The number of frames to use will vary by observation, so this operation is not part of the automated pipeline.
iii) Scattered light. Although some observations have been taken to characterize scattered light, no photometric modeling of the stray light has been made or applied to the data. Those observations have only been used to optimize the planned imaging at Pluto encounter to minimize the effect of stray light.

Ongoing in-flight calibration observations will be analyzed to assess the long term stability of the calibration.

Data

The observations in this data set are stored in data files using standard Flexible Image Transport System (FITS) format. Each FITS file has a corresponding detached PDS label file, named according to a common convention. The FITS files may have image and/or table extensions. See the PDS label plus the document collection for a description of these extensions and their contents.

This Data section comprises the following sub-topics:

- Filename/Product IDs
- Instrument description
- Other sources of information useful in interpreting these Data
- Visit Description, Visit Number, and Target in the Data Labels

Filename/Product IDs

The filenames and Local product Identifiers (LID) of observations adhere to a common convention, e.g.:

```
lsb_0123456789_0x53c_eng.fit
^^^ ^^^^^^^^^^ ^^^^^ ^^^\__/
|         |        |     |  ^^
|         |        |     |   |
|         |        |     |   +--File type (includes dot)
|         |        |     |      - .FIT for FITS file
|         |        |     |      - .LBLX for PDS label
|         |        |     |      - not part of LID
|         |        |     |
|         |        |     +--ENG for CODMAC Level 2 data
|         |        |        SCI for CODMAC Level 3 data
|         |        |
|         |        +--Application ID (ApID) of the telemetry data
|         |           packet from which the data come
|         |           N.B. ApIDs are case-insensitive
|         |
|         +--MET (Mission Event Time) i.e. Spacecraft Clock
|
+--Instrument designator
```

Instrument Designator(s):

Instrument Designator	Description
LSB	LEISA, Read minus Reset data
LRW	LEISA, Raw Read and Reset data

See SOC Instrument Interface Control Document (ICD) within the PDS for more details (PDS4 LID `urn:nasa:pds:nh_documents:mission:soc_inst_icd`).

Mission Event Time (MET)

Note that, depending on the observation, the Mission Event Time (MET) in the data filename and in the LID may be similar to the MET of the actual observation acquisition, but should not be used as an analog for the acquisition time. The MET is the time that the data are transferred from the instrument to spacecraft memory and is therefore not a reliable indicator of the actual observation time. The PDS labels are better sources to use for the actual timing of any observation. The specific keywords for which to look are:

- start_date_time
- stop_date_time
- start_clock_count
- stop_clock_count

Application ID (ApID)

Here is a summary of the types of files generated by each ApID (N.B. ApIDs are case-insensitive) along with the instrument designator that go with each ApID:

ApIDs	Data product description/Prefix(es)
0x53c	LEISA Lossless (CDH 1)/LRW,LSB
0x54b	LEISA Lossless (CDH 2)/LRW,LSB
0x53d	LEISA Packetized (CDH 1)/LRW,LSB
0x54c	LEISA Packetized (CDH 2)/LRW,LSB
0x53e	LEISA Lossy (CDH 1)/LRW,LSB
0x54d	LEISA Lossy (CDH 2)/LRW,LSB

There are other ApIDs that contain housekeeping values and other values. See the SOC Instrument ICD for more details: urn:nasa:pds:nh_documents:mission:soc_inst_icd

Please note that not all ApIDs may be found in this data set.

Instrument description

Refer to the following files for a description of this instrument.:

- New Horizon LEISA instrument overview: urn:nasa:pds:nh_documents:ralph:leisa_inst_overview
- Ralph Space Science Review (SSR) paper: urn:nasa:pds:nh_documents:ralph:ralph_ssr
- SOC Instrument ICD: urn:nasa:pds:nh_documents:mission:soc_inst_icd
- Ralph SPICE Instrument Kernel: urn:nasa:pds:nh_documents:ralph:nh_ralph_v100_ti

Other sources of information useful in interpreting these Data

Refer to the following files for more information about these data:

- NH Mission Trajectory Table: urn:nasa:pds:nh_documents:mission:nh_mission_trajectory
- Field of View Illustration: urn:nasa:pds:nh_documents:mission:nh_fov
- Ralph SPICE Instrument Kernel: urn:nasa:pds:nh_documents:ralph:nh_ralph_v100_ti

Visit Description, Visit Number, and Target in the Data Labels

The observation sequences were defined in Science Activity Planning (SAP) documents and grouped by Visit Description and Visit Number. The SAPs are spreadsheets with one Visit Description & Number per row. A nominal target is also included on each row and included in the data labels but does not always match with the target name field's value in the data labels. In some cases, the target was designated as right_ascension_angle, declination_angle pointing values in the form “right_ascension_angle, declination_angle =123.45,-12.34" indicating Right Ascension and Declination, in degrees, of the target from the spacecraft in the Earth Equatorial J2000 inertial reference frame. This indicates that either the target was a star, or the target's ephemeris was not loaded into the spacecraft's attitude and control system which in turn meant the spacecraft could not be pointed at the target by a body identifier and an inertial pointing value had to be specified as Right Ascension and Declination values. PDS-SBN practices do not allow putting a value like right_ascension_angle, declination_angle =... in the PDS target name keyword's value. In those cases, the PDS target purpose value is set calibration. Target name may be None for a few observations in this data set; typically, that means the observation

is a functional test so None is an appropriate entry for those targets, but the PDS user should also check the nh:observation_description and nh:sequence_id keywords in the PDS label, plus the provided sequence list (`urn:nasa:pds:nh_documents:ralph:seq_leisa_pluto`) to assess the possibility that there was an intended target. These two keywords are especially useful for star targets as often stars are used as part of instrument calibrations and are included as part of the sequencing description which is captured in these keywords.

Ancillary Data

The geometry items included in the data labels were computed using the SPICE kernels archived in the New Horizons SPICE data set, NH-J/P/SS-SPICE-6-V1.0.

Every observation provided in this data set was taken as a part of a particular sequence. A list of these sequences has been provided within the NH Ralph document collection (see PDS4 LID `urn:nasa:pds:nh_documents:ralph`) within the PDS, one file for each mission phase. The sequence identifier and description are included in the PDS label for every observation.

N.B. While every observation has an associated sequence, every sequence may not have associated observations. Some sequences may have failed to execute due to spacecraft events (e.g., safing). No attempt has been made during the preparation of this data set to identify such empty sequences.

Time

There are several time systems, or units, in use in this dataset: New Horizons spacecraft MET (Mission Event Time or Mission Elapsed Time), UTC (Coordinated Universal Time), and TDB (Barycentric Dynamical Time).

This section will give a summary description of the relationship between these time systems. For a complete explanation of these time systems the reader is referred to the documentation distributed with the Navigation and Ancillary Information Facility (NAIF) SPICE toolkit from the PDS NAIF node, (see http://naif.jpl.nasa.gov/).

The most common time unit associated with the data is the spacecraft MET. MET is a 32-bit counter on the New Horizons spacecraft that runs at a rate of about one increment per second starting from at value of zero at “19.January, 2006 18:08:02 UTC” or “JD2453755.256337 TDB.”

The leapsecond adjustment (DELTA_ET = ET - UTC) was 65.184s at NH launch, and the first four additional leapseconds occurred at the ends of 12/2009, 06/2012, 06/2015, and 12/2016. Refer to the NH SPICE data set, NH-J/P/SS-SPICE-6-V1.0, https://doi.org/10.17189/1520109, and the SPICE toolkit documentation, for more details about leapseconds.

The data labels for any given product in this dataset usually contain at least one pair of common UTC and MET representations of the time at the middle of the observation. Other portions of the products, for example tables of data taken over periods of up to a day or more, will only have the MET time associated with a given row of the table.

For the data user's use in interpreting these times, a reasonable approximation (+/- 1s) of the conversion between Julian Day (TDB) and MET is as follows:

```
JD TDB = 2453755.256337 + ( MET / 86399.9998693 )
```

For more accurate calculations the reader is referred to the NAIF/SPICE documentation as mentioned above.

Reference Frame

Geometric Parameter Reference Frame

Earth Mean Equator and Vernal Equinox of J2000 (EMEJ2000) is the inertial reference frame used to specify observational geometry items provided in the data labels. Geometric parameters are based on best available SPICE data at time of data creation.

Epoch of Geometric Parameters

All geometric parameters provided in the data labels were computed at the epoch midway between the start_date_time and stop_date_time label fields.

Software

The observations in this data set are in standard FITS format with PDS labels and can be viewed by a number of PDS-provided and commercial programs. For this reason, no special software is provided with this data set.

Confidence Level Overview

During the processing of the data in preparation for delivery with this volume, the packet data associated with each observation were used only if they passed a rigorous verification process including standard checksums.

In addition, raw (CODMAC Level 2) observation data for which adequate contemporary housekeeping and other ancillary data are not available may not be reduced to calibrated (CODMAC Level 3) data. This issue is raised here to explain why some data products in the raw data set may not have corresponding data products in the calibrated data set.

Known Issues

Below is a list of all deficiencies and irregularities that are known to exist at the time of publication.

Radiometric calibration scaling factor correction

A correction scaling factor in the LEISA radiometric calibration of 0.74 has been reported by Protopapa et al. 2020. To make it consistent with MVIC, LEISA level 2 data need to be multiplied by 0.74. For more details see Protopapa et al. 2020 (DOI: 10.3847/1538-3881/ab5e82).

Quaternion FITS extension errors

The unnamed FITS extension 7, Et Quaternion in the label files, has incorrect values for the 5th column. The data in the 5th column is the Z-value of the Quaternion.

NaNs and flat field file

A note to the user that the original flatmap file used to calibrate the data in this mission phase contained NaNs and so all the calibrated images contain NaNs. The issue was found during the KEM1 Encounter phase and fixed there by replacing all NaNs with -1 in the flatmap file. This flatmap file (PDS4 LID `urn:nasa:pds:nh_leisa:calibration_files:flatmap::3.0`), was migrated to PDS4, and is what is referenced in the calibrated image PDS4 labels in this collection. This fix NaN fix was not added or applied to prior mission phases, nor were the images recalibrated then or during migration to PDS4. If you wish to get the original flatmap file, please look in the PDS3 archive of this mission phase.

Data coverage and quality

Every observation provided in this data set was taken as a part of a particular sequence. For this data set, these sequences can be found in the Ralph document collection under PDS4 LID `urn:nasa:pds:nh_documents:ralph:seq_leisa_pluto`. Please note that some sequences provided may have zero corresponding observations.

Refer to the Confidence Level Overview section above for a summary of steps taken to assure data quality.

Caveat about target name in PDS labels and observational

The downlink team on New Horizons has created an automated system to take various uplink products, decode things like Chebyshev polynomials in command sequences representing celestial body ephemerides for use on the spacecraft to control pointing, and infer from those data what the most likely intended target was at any time during the mission. This works well during flyby encounters and less so during cruise phases and hibernation.

The user of these PDS data needs to be cautious when using the target name and other target-related parameters stored in this data set. This is less an issue for the plasma and particle instruments, more so for pointed instruments. To this end, the heliocentric ephemeris of the spacecraft, the spacecraft-relative ephemeris of the inferred target, and the inertial attitude of the instrument reference frame are provided with all data, in the J2000 inertial reference frame, so the user can check where that target is in the Field Of View (FOV) of the instrument.

Finally, note that, within the FITS headers of the data products, the sequence tables, and other NH Project-internal documents used in this data set, informal names are often used for targets instead of the canonical names used within the PDS labels. For example, during the Pluto mission phase, instead of the target name '15810 ARAWN (1994 JR1)' there might be found any of the following: 1994JR1; 1994 JR1; JR1. However, within the context of this data set, these project abbreviations are not ambiguous (e.g. there is only one NH target with 'JR1' in its name), so there has been, and will be, no attempt to expand such abbreviations where they occur outside formal PDS keyword values.

Contact Information

For any questions regarding the data format of the archive, contact the New Horizons LEISA Principal Investigator: Alan Stern, Southwest Research Institute

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Further Reading

Protopapa, Silvia, Cathy B. Olkin, Will M. Grundy, Jian-Yang Li, Anne Verbiscer, Dale P. Cruikshank, Thomas Gautier, Eric Quirico, Jason C. Cook, Dennis Reuter, Carly J. A. Howett, Alan Stern, Ross A. Beyer, Simon Porter, Leslie A. Young, Hal A. Weaver, Kim Ennico, Cristina M. Dalle Ore, Francesca Scipioni, and Kelsi Singer, Disk-resolved Photometric Properties of Pluto and the Coloring Materials across its Surface, The Astronomical Journal, Volume 159, Number 2, 2020. https://doi.org/10.3847/1538-3881/ab5e82

Steffl, A.J., J. Peterson, B. Carcich, L. Nguyen, and S.A. Stern, NEW HORIZONS SPICE KERNELS, V1.0, NH-J/P/SS-SPICE-6-V1.0, NASA Planetary Data System, 2007. https://doi.org/10.17189/1520109