國 立 中 央 大 學

機械工程研究所

碩/博士論文

模版 ncuthesisCJK 使用說明

An example in LaTeX/XeLaTeX

研究生: 羅吉昌

指導教授: 羅吉昌

共同指導: 甲教授
乙教授

中 華 民 國 一百零二 年 六 月

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(101 年 9 月最新修正版)

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中文摘要

關鍵字： 碩博士論文，體裁檔，LaTeX，XeLaTeX

此論文範例得以完成是由於體裁檔(ncuthesis.cls)的完成。期間多方閱讀、吸收、漸有所獲，直至發掘兩篇網路文章，深入了解後再加入中文化及適當增修而成。本體裁檔可再增修，複製，直接採用做個人用途，或供單位使用，唯不可做商業用途。

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- 如何使用LaTeX 請看第二章說明。
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An example in LaTeX/XeLaTeX

英文摘要

Keywords: Master/Doctorial thesis, Class file, LaTeX, XeLaTeX

Source

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Features

- Master/Doctorial thesis stipulated by National Central University.
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- Compilable by pdfLaTeX or XeLaTeX.
- Oneside or twoside printing.
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- Page layout and parameters.
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- How to use this package –– Chapter 1.
- How to use LaTeX (very brief) –– Chapter 2.
- How to generate references –– Chapter 3.

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謝誌

體裁檔受啓發於兩位英美教授於網路上的文章，並經吾人中文化及適當增修而成。本體裁檔可再增修，複製，直接採用做個人用途，或單位使用，唯不可做商業用途。請尊重上述兩位教授的無私奉獻。

- 感謝TeX/LaTeX網路社群內，龐大的TeX/LaTeX社群及其網頁提供無價資訊。
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- 2013/06/13碩士班 葉信麟同學發現目錄頁碼不正確。
- 2013/07/04碩士班 林億同學發現附錄節碼不正確。

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\subtitle	: 論文英文題目
\logo	: 封面校徽(預設中央校徽)
\author	: 作者
\mprof	: 指導教授
\sprofi, \sprofii	: 兩位共同指導
\degreedate	: 中 華 民 國 XXX 年 X 月
\copyyear	: 著作完成年
\includepdf	: 插頁指令，需pdfpages巨集
\fontsize...\selectfont	: 設定字大小行距
\bookbone	: 書脊短時用
abstractcn	: 中文摘要環境名，檔案則爲abstractcn.tex
abstracten	: 中文摘要環境名，檔案則爲abstracten.tex
acknowledgements	: 謝誌環境名，檔案則爲acknowledge.tex
appendA	: 附錄一環境名，檔案則爲appendix.tex
appendB	: 附錄二環境名，檔案則爲appendix.tex
symbols	: 符號說明環境名，檔案則爲symbol.tex

1. Introduction

According to Hindu cosmological mythology, ancient people believe that a giant turtle bears the world on its back. Even after we stepped onto the moon at 1969, there are still plenty that we cannot explain. In the novel Lord of the Rings, the author named the path between hobbits as Mordor, which is also the name of the dark area on Pluto's moon, Charon. Recently, Mission New Horizons retrieved valuable data about Charon and Pluto. This thesis aims to explain the formation mechanisms of the red cap on the pole of Charon (fig. 1), especially during the long cold dark period, through observations in extreme ultra-violet (EUV) and vacuum ultra-violet (VUV) irradiation.

Composition of Charon

The main composition on the surface of Charon is H_2O. According to Infrared (IR) spectroscopy, it is a mixture of 90 % H_2O and 10 % tholin at millimetre depth. The second most dominant component is ammonia hydrate, which can be observed by earth-based telescopes (brown 2000, cook 2007). In far IR spectrum taken by LEISA camera on the New Horizons, concentrated ammonia is found on Organa crater (fig 2.) and throughout Charon (fig 3.) (Grundy 2016a). The third component which forms the dark red cap (tholin?) is cold-trapped methane from Pluto's atmosphere ejecta (Hoey 2017). The presence of nitrogen and other ejecta from Pluto are neglected in this thesis because according to the model of Hoey et al. (2017) (fig.4), during New horizons' approach, 98 % of the arrived ejecta is CH_4. Charon's atmospheric pressure is further constrained by New Horizons to be below 0.3 nano bars, which is 4×10^{-13} torr for all 14 atoms and molecules including CO, H_2, CH_4, Ne, Ar, etc. (fig. 5). CH_4 remains undetectable when we convert the momentum of CH_4 with 7 hops on the surface of Charon until deposited onto cold enough part is $1/times10^{-11}$ Pa, which is $7.5/times10^{-14}$ torr

(Grundy 2016b).

VUV irradiation

Ly-α appears to be the largest source in the dark side of Charon, with attributions from both solar occultation (70EUV irradiation

Apart from VUV irradiation, EUV irradiation also took part. VUV irradiation is believed to be the main process to convert CH_4 into heavier molecules which remained on the surface of Charon until the temperature of Charon become 60 K, at which methane evaporates from the ice. The ice is then further processed by EUV, solar wind, coronal mass ejections and interstellar pickup ions, etc to produce the tholin on Charon (Grundy 2016b). The EUV irradiation (>12.4 eV) is $8.7/times10^{7}eVcm^{-2}s^{-1}$ at mean heliocentric distance 39 A.U. whereas VUV irradiation (Ly-α) is $1.9/times10^{9}eVcm^{-2}s^{-1}$. In order to investigate the effectiveness of EUV to VUV irradiation, we kept temperature of CH_4+NH_3 (3:2 & 1:5) and CH_4+NH_3+H_2O (5:3:4) ice mixtures at 15 K and use the monochromatic 30.4 nm (He II) light provided by High flux beamline at National Synchrotron Radiation Research Centre (NSRRC) in Taiwan to irradiate the ice mixtures.

H_2O involved?

We compared the conditions of CH_4+NH_3 and CH_4+NH_3+H_2O because tholin on Titan is believed to be formed by CH_4+N_2 and a similar colour was observed on Charon. Charon is different from Titan as H_2O dominates on Charon. What are the differences between tholin formed by CH_4+NH_3 and CH_4+N_2? What role does H_2O play on Charon in the formation of tholin? Is it just diluting the formation or new compounds are formed?

In this thesis, we will introduce the formation reaction mechanisms of CH_4+NH_3 ice mixtures in EUV and VUV irradiation (section 3), the formation reaction mechanisms of CH_4+NH_3+H_2O ice mixtures in EUV and VUV irradiation (section 4), and the residues of these mixtures and a brief comparison with tholin on Titan will be made (section 5). With these results, we will have a better understanding about Charon and some astrophysical implications will be presented (section 6).

2. Methods

2.1 Laboratory Astrophysics

To study the chemical reactivity in astrophysical environment experimentally, we conducted our experiments in Interstellar photoprocessing system (IPS) (Chen et al. 2014), an ultrahigh vacuum chamber with base pressure 3×10^{-10} torr and 14 K, corresponds to a density of 10^6 cm^{-3}, similar to dense cloud interiors. The system will be introduced in detail in section 2.1.1. To simulate the irradiation in interstellar environments, we use a micro-wave discharge hydrogen lamp (MDHL) and monochromatic extreme-ultraviolet irradiation (EUV) 30.4 nm to irradiate our ice mixtures, and they will be introduced in section 2.2.1 and 2.2.2 respectively. The experimental protocols will be elaborated in section 2.3. In order to better understand the physics behind, some basic theories of Infrared spectroscopy and concepts of chemical kinetics used in data analysis are included in section 2.4 and 2.5 respectively. To demonstrate the ice mixtures in KBOs, we used different configurations of ice mixtures that refers to different sections in chapter 3 and chapter 4.


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3. Experimental Results of CH_4 + NH_3 ice mixtures

According to Grundy et al. (2016), CH_4 from Pluto may accumulate by cold-trapping, onto surface of Charon. The amount of CH_4 varies throughout the surface of Charon because it depends on duration of temperature below 25 K. The duration depends on diurnal motion and thermal inertia of Charon. With a tilted axis of 112 degrees to the ecliptic, higher concentration of CH_4 will accumulate at the pole (see chapter 1 for details). Therefore, we investigate different concentrations of CH_4+NH_3 ice mixtures and answer several questions: Will different concentration of CH_4 mix with high concentration of ammonia observed on crater position and throughout the surface of Charon (Grundy et al. 2016) have structure difference in accumulation of tholin? Are there variations of photo-products when concentration of CH_4 differ during warm-up? Since both EUV and VUV irradiation irradiates onto Charon, are there any differences when we change the photon source from VUV to EUV to irradiate the ice mixtures?

The main source to irradiate the dark side of Charon is Lyα reflected by interplanetary medium (Grundy 2016). Other sources such as the energetic ions in solar wind, consists of mainly H^+, He^+, He^{++} and O^{2+} etc are originated from solar corona or IPM. These ions would also reflect solar irradiation to the dark side of Charon. Among these irradiations, we picked He II irradiation because He II is 3 – 20 times more intense then He I during a solar flare. As it varies, it is difficult to estimate the dose onto Charon. Besides, electronic flux is also present in solar wind but it is one order of magnitude lower than proton flux. The flux for energetic electrons observed at the 1 A. U. position is

available (http://www.swpc.noaa.gov/products/goes-electron-flux). Although electron flux is much less important than Lyα, and their flux varies, we also compare the electron irradiation experiment done by Kim and Kaiser (2011) on CH_4+NH_3 ice mixtures in this chapter.

When Charon is shine by direct sun light, the surface temperature increases and deliver the heat to the poles by conduction. From the model of Grundy et al. (2016), the surface temperature of the pole area would increase to 60 K that the heating rate depends on the thermal conductivity of Charon. To demonstrate the heating process, we warmup our ice mixture with a heating rate 1 K/min and monitor the ice by both QMS and scanning IR spectra with 5 K intervals. We will look into whether there are new species formed during warmup and monitor the gas phase desorption.

Finally, in this chapter, after we focus on the concentration effect of CH_4 on photo-products, photon energy effects, species detected during warmup phases, we present the residues accumulated by irradiating CH_4+NH_3 ice mixtures with different ratios. Since both tholin formed on Titan and Charon has similar colour, we also compare the IR spectra of MDHL, NSRRC with different configurations with the residues on Titan with experiments done by Imanaka et al.

3.1 The concentration effect of CH_4 on production of C_2H_6 and CN^-

We first look into the concentration effects of CH_4 by irradiation by VUV irradiation. Before and after deposition, we scanned an IR spectrum and plotted the absorbance of the ice mixtures. figure 3.1.1 plots the absorbance of the CH_4+NH_3 ice mixtures in different ratios. Due to the ice thickness, the infra-red spectrum of CH_4+NH_3 = 3:2 consist of 900 ML of CH_4 and 600 ML of NH_3 is tilted due to interference. Since the amount of ammonia is fixed (600 ML) in all the ratios, other ratios has less CH_4 and this problem is less serious. This is also not

observed in the ice mixtures after irradiation. Using the same reference spectrum, that is the infra-red spectrum recorded before deposition, we plotted the infra-red spectrum of irradiated ice mixture in figure 3.1.2. It shows the absorbance of each ratio after irradiation. We labelled the peaks which we used to calculate the column densities onto the graph. Main products we have detected are C_2H_6, CN^- and C_3H_8. The peak positions with the references are listed at table 3.1.

From infra-red absorption spectrum and their positions, we assigned the peak 2086 cm^{-1} to CN^- but not a combination of HCN and CN^- because of we cannot observe the HCN bending mode located at 848 cm^{-1}. Although in the case CH_4 + NH_3 = 3:2, we may observe a peak located at 820 cm^{-1}, the peak is with a FWHM half of HCN and it disappeared at 50 K. Since 50 K is the desorbing temperature of C_2H_6 and the position is v12 mode of C_2H_6, we assign the 820 cm^{-1} peak as C_2H_6. As the absence of HCN bending mode, we may assign our peak located at 2086 cm^{-1} as CN^-. Other assignments such as C_2H_6 and C_3H_8 are observed with multiple peaks.

We integrated the area and divided by the absorption strength stated in table 3.2. Although we understand that there is an average error in absorption strengths of 20 % and the absorption strengths changes when matrix differs, we use the same absorption strength throughout our discussion to give a brief concept on what is the column density of the species and how is the absorption area changes when concentrations of ice mixtures and photon energy are changed. For the case of CN^-, we know that CN^- has a bond order =3 by its molecular orbitals which is different from CN stretching (bond order 2.5) which is very sensitive to the matrix environment. As an example, by Borget et al. (2012), the CN stretch in amino acetonitrile change by factor of 2 between the pure molecule itself and in a mixture of amino acetonitrile and H_2O (1:3). Here, we adopt the absorption strengths stated in table 3.2 and neglect the error in absorption strengths.

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[8] Chinese character \cjk within \section{} does not work using pdflatex, + \includegraphics,
http://tex.stackexchange.com/a/126570

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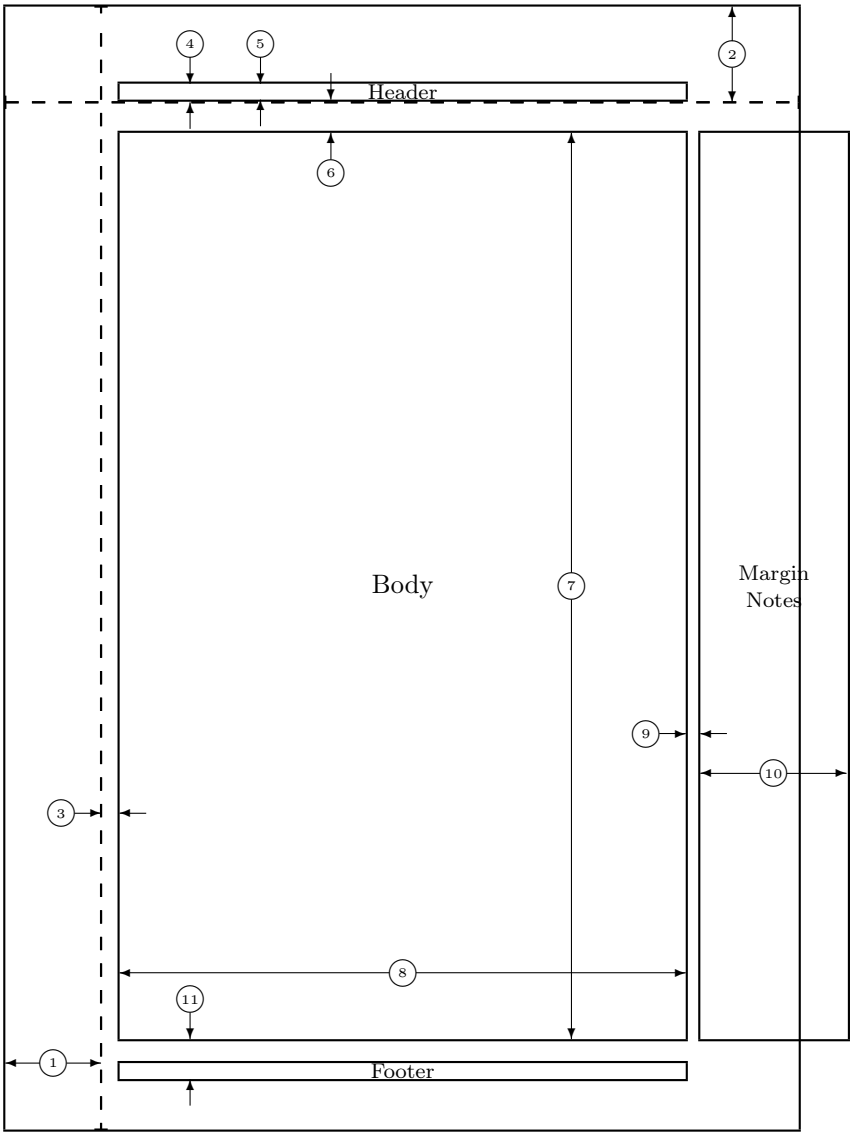

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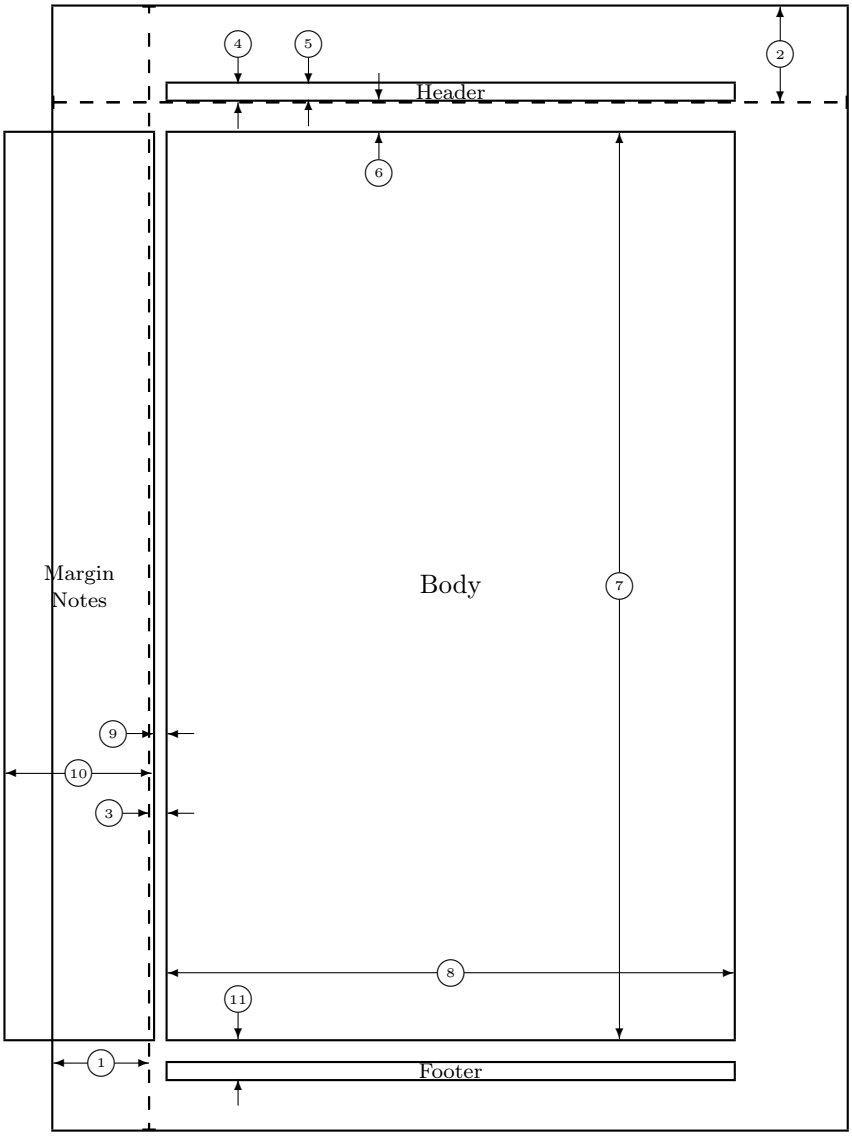

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